US Army Corps
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Waterways Experiment
Station

Technical Report HL-91-10
October 1997

Red River Waterway, Lock and Dam 3

Report 2
Navigation Alignment Conditions
Hydraulic Model Investigation

by Ronald T. Wooley

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Prepared for U.S. Army Engineer District, Vicksburg

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U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
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Report 2 of a series

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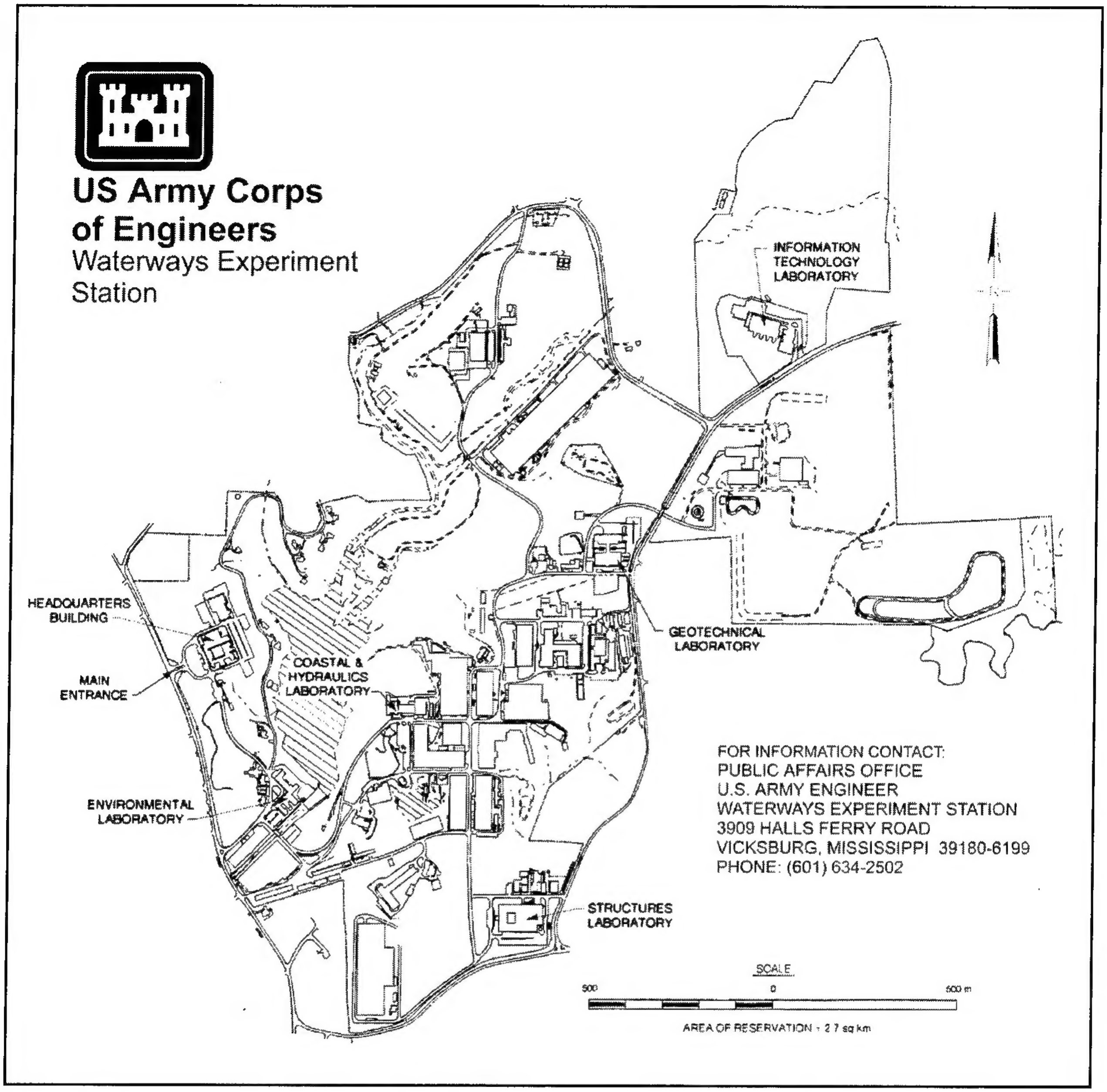

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Contents

List of Figures

List of Tables

Preface

This model investigation was conducted for the U.S. Army Engineer District, Vicksburg, and authorized by DA Form 2544, Order No. NCR-IA-85-0167, dated 27 August 1985, to the U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. The study was conducted in the Hydraulics Laboratory of WES during the period January 1984 to October 1991.

In addition to the fixed-bed navigation model study, two physical model studies and two numerical model studies were conducted at WES. The additional studies included a hydraulic movable-bed model study (Report 3); a hydraulic structures model study (Report 4); a numerical model sedimentation study of upstream and downstream approaches to Lock and Dam No. 4 (Report 5); and a numerical model sedimentation study of the Red River upstream and downstream of Lock and Dam No. 4 (Report 6). This is Report 2 of the series. Report 1, to be published later, will summarize all of the model studies.

During the course of the model study, representatives of the Vicksburg District and other navigation interests visited WES at different times to observe special model experiments and to discuss the results of those experiments. The Vicksburg District was informed of the progress of the study by monthly progress reports and special presentations at the conclusion of each experiment.

This report is being published by the WES Coastal and Hydraulics Laboratory (CHL). The CHL was formed in October 1996 with the merger of the WES Coastal Engineering Research Center and the Hydraulics Laboratory. Dr. James R. Houston is the Director of the CHL, and Messrs. Richard A. Sager and Charles C. Calhoun, Jr., are Assistant Directors.

The first-line review of this report was conducted by Mr. T. J. Pokrefke, Acting Chief of Navigation Division. The principal investigator in immediate charge of the model study was Mr. R. T. Wooley, assisted by Messrs. E. Johnson, E. A. Frost, and J. W. Sullivan and Ms. D. P. George. This report was prepared by Mr. Wooley.

Director of WES during preparation and publication of this report was Dr. Robert W. Whalin. Commander was COL Robin R. Cababa, EN.

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Conversion Factors, Non-SI to SI Units of Measurements

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic meters
degrees (angle)	0.01745329	radians
feet	0.3048	meters
miles (U.S. statute)	1.609344	kilometers
slug-ft	4.447086	kilogram-meters

1 Introduction

Location and Description of Prototype

The Red River flows easterly from the northwest portion of Texas along the border between Texas and Oklahoma through southwestern Arkansas into northwestern Louisiana then southeasterly to join the Old River and form the Atchafalaya River (Figure 1). Flow in the upper part of the Red River is controlled by releases from Denison Dam, which is located on the Texas-Oklahoma state line. Flow from the Mississippi River through Old River Diversion Channel into the Atchafalaya River has considerable backwater effect on upstream stages including the Lower Red River. A 75- by 1,200-ft[1] lock at the mouth of Old River provides navigation between the Mississippi, Red, and Atchafalaya Rivers.

Prior to construction of the locks and dams, the Red River had large fluctuations in stage, a shifting bed, caving banks, and unpredictable shoaling. The controlling depths of natural conditions in the Red River had averaged about 6 ft from the mouth to Alexandria, LA, and about 5 ft from Alexandria to Shreveport, LA, from January to July and generally less the remainder of the year. The controlling depths during some periods were as low as 1 to 2 ft in the Alexandria to Shreveport reach. The movement of cargo by barges in the Red River was limited due to long periods of low flows, narrow bends of short radii, and a heavy sediment load.

Present Development Plan

Public Law 90-483, 90th Congress, approved 13 August 1968, authorized the construction of the "Red River Waterway, Louisiana, Texas, Arkansas, and Oklahoma," project in accordance with the recommendations of the Chief of Engineers as contained in House Document No. 304, 90th Congress, 2nd Session. The Appropriations Act of 1971, approved 7 October 1970, as Public Law 91-439, provides the authority to initiate preconstruction planning from the Mississippi River to Shreveport reach of the project.

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1 A table of factors for converting non-SI units of measurement to SI units is found on page viii.

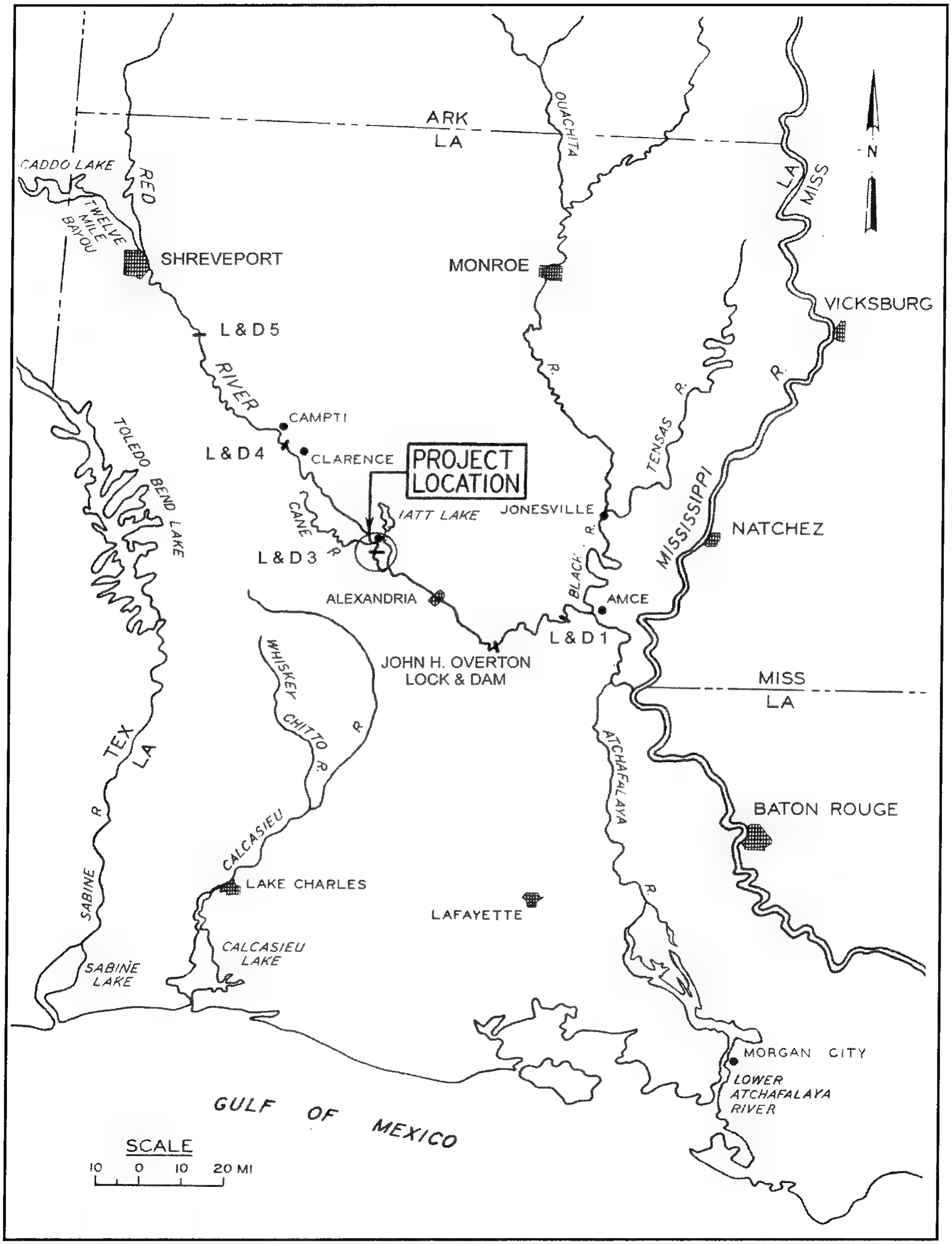

Figure 1. Location map

Lock and Dam No. 3 is proposed for construction in a cutoff channel between 1967 river miles 140 and 142, and about 53 channel miles above John H. Overton Lock and Dam. The lock and dam will be the third lock in a series of five locks and dams designed to furnish the required maximum lift of 141 ft to provide year-round navigation on the Old and Red River Waterway from the Mississippi River to Shreveport, a distance of 236 miles. The recommended plan consists of an 84-ft-wide by 685-ft-long lock, a spillway containing six 60-ft-wide by 42-ft-high tainter gates, and a 315-ft-long fixed-crest weir adjacent to the gated spillway. The structures will provide a normal upper pool at el 95.0[1] with a maximum lift of 31 ft in the lock chamber from Pool 2 at el 64.0. The lock will be located on the left side of the cutoff channel with the gated spillway adjacent to the lock and the overflow weir being adjacent to the spillway.

Need for and Purpose of Model Study

The general design of Lock and Dam No. 3 was based on sound theoretical design practice and experience with similar structures. However, navigation conditions vary with location and flow conditions upstream and downstream of a structure, and an analytical study to determine the hydraulic effects that can reasonably be expected to result from a particular design is both difficult and inconclusive. Since Lock and Dam No. 3 was to be located in an excavated channel bypassing the natural river channel, it was important that the alignment of the channel and the arrangement of the lock and dam be satisfactory for navigation. Therefore, a comprehensive model study was considered necessary to investigate conditions that could be expected with the proposed design and to develop modifications required to ensure satisfactory navigation conditions. The specific purposes of the model study were as follows:

a. To determine optimum channel alignment, channel training structures required, and location of auxiliary lock walls.

b. To develop modifications required to provide satisfactory navigation conditions and minimize construction.

c. To provide data for use in a movable-bed study to determine the effects of the changes on the movement of sediment and its effects on channel width and depth.

d. To determine the effect of the hinged pool operations on the current velocities and alignment and on navigation into the lock approach.

e. To evaluate navigation conditions with future bed configurations as predicted by the movable-bed study and to develop any modifications required to maintain acceptable navigation conditions.

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[1] All elevations (el) cited herein are in feet referred to the National Geodetic Vertical Datum (NGVD).

f. To demonstrate to navigation interests the conditions resulting from the proposed design and to satisfy these interests of its acceptability from a navigation standpoint.

2 The Model

Description

The model (Figure 2) reproduced approximately 3.5 miles of the Red River channel, extending approximately 13,500 ft upstream of the dam and 4,800 ft downstream of the dam, including the adjacent overbank area. Also included were the proposed 84-ft-wide by 685-ft-long lock, a spillway containing six 60-ft-wide tainter gates, and a 315-ft-long fixed crest weir. The model was of the fixed-bed type, with the channel and overbank areas molded in sand-cement mortar to sheet metal templates. Portions of the model, where changes in bank alignments and channel configurations could be anticipated, were molded in pea gravel to permit modifications that might be required to provide satisfactory conditions. The lock, dam crest, piers, and guard walls were fabricated out of sheet metal and/or Plexiglas. The dam gates were simulated schematically with simple sheet metal, slide-type gates. The model was molded to a recent hydrographic and topographic survey.

Scale Relations

The model was built to an undistorted scale of 1:100, model to prototype, to effect accurate reproduction of velocities, crosscurrents, and eddies affecting navigation. Other scale ratios resulting from the linear scale ratio are as follows:

Characteristic	Ratio[1]	Scale Relation Model:Prototype
Length	L_r	1:100
Area	$A_r = L_r^2$	1:10,000
Velocity	$V_r = L_r^{1/2}$	1:10
Time	$T_r = L_r^{1/2}$	1:10
Discharge	$D_r = L_r^{5/2}$	1:100,000
Roughness (Manning's n)	Manning's n = $L_r^{1/6}$	1:2.15

[1] Ratios are given in terms of length L.

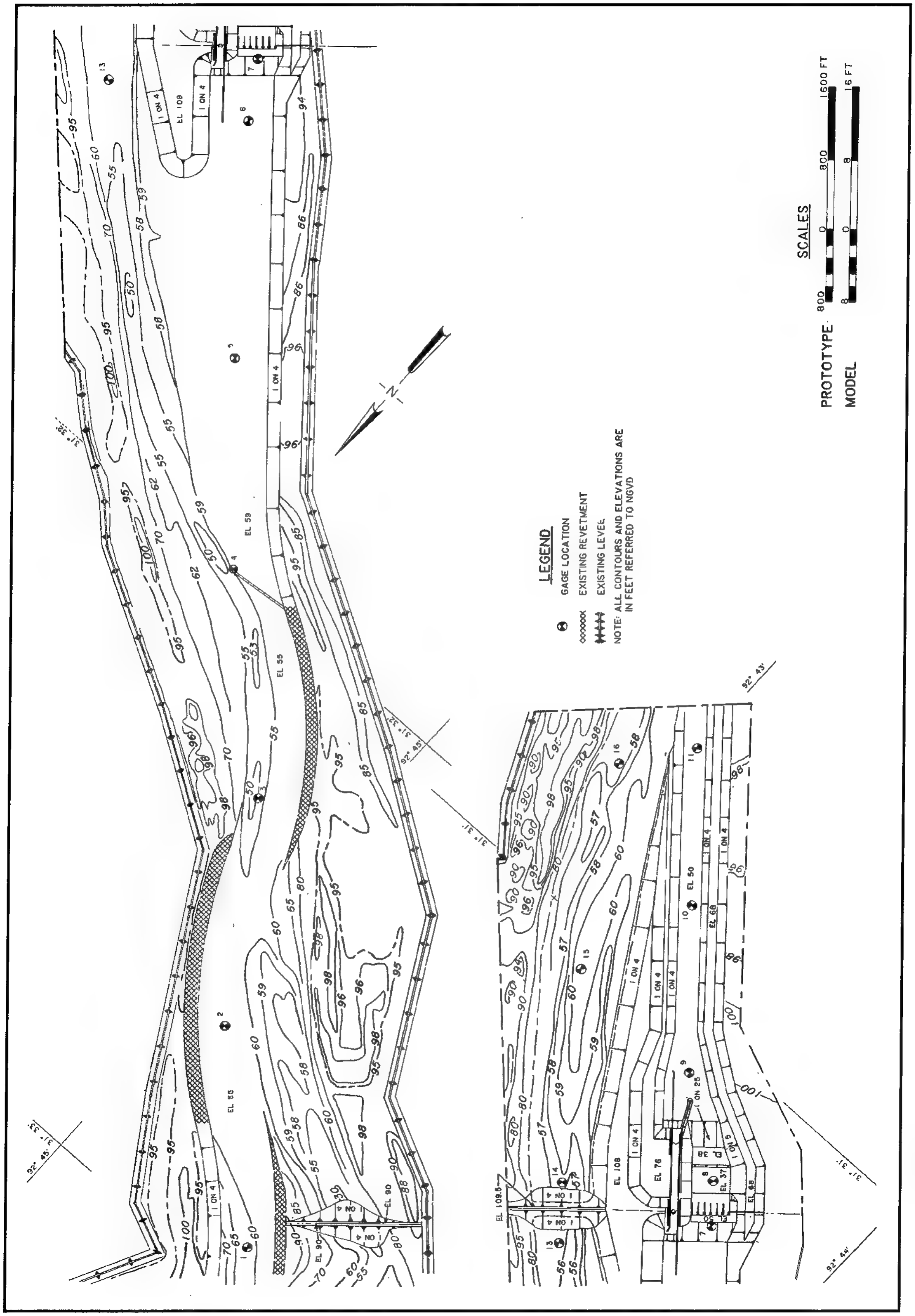


Figure 2. Model layout

Measurements of discharges, water-surface elevations, and current velocities can be transferred quantitatively from model to prototype equivalents by means of these relations.

Appurtenances

Water was supplied to the model by means of a 10-cfs pump operating in a recirculating system. The discharge was controlled and measured at the upper end of the model by means of a valve and venturi meter. Water-surface elevations were measured by means of piezometer gauges located in the model channel and connected to a centrally located gauge pit (Figure 2). A movable tailgate was provided at the lower end of the model to control the tailwater elevation downstream of the dam, and the slide-type gates in the spillway were used to maintain the upper pool elevation during controlled riverflows.

Velocities and current directions were determined in the model by means of wooden cylindrical floats weighted on one end to simulate the maximum permissible draft for loaded barges using the waterway (9-ft prototype). A model tow, consisting of a towboat and four barges, was used to determine and demonstrate the effects of currents on tows approaching and leaving the lock and moving through the river channel upstream and downstream of the lock. The overall size of the towboat and tow used in the study was 685 ft long by 70 ft wide loaded to a draft of 8 ft. The towboat was equipped with twin screws and propelled by a small electric motor operating from batteries located in the tow; the rudders and speed of the tow were remote controlled. The towboat could be operated in forward or reverse with the power adjusted by means of a rheostat to a maximum speed comparable to that of the towboats expected to use the Red River Waterway.

Model Adjustment

Inclusion of the proposed lock and dam plans in the initial model construction precluded adjustment of the model to the existing conditions. This type of adjustment was not considered necessary since the proposed improvements would involve considerable change from existing conditions. The model was constructed with a brushed-cement mortar finish to provide a roughness factor (Manning's n) of about 0.0135, which corresponds to a prototype of about 0.029. Based on experience with other models of this type, brushed concrete gives a close approximation of the roughness required to reproduce prototype conditions.

3 Experiments and Results

Experiments were concerned primarily with the study of flow patterns, measurements of velocities and water-surface elevations, and the effects of currents on the movement of the model tow into the lock approaches during navigable riverflows. Most of the modifications were developed during preliminary experiments. Data obtained during these experiments were sufficient to assist in the development of the plan that appeared to provide satisfactory results. Results of the preliminary experiments are not included in this report.

Experiment Procedures

A selection of representative riverflows were used for the experiments based on information furnished by the U.S. Army Engineer District, Vicksburg, as follows:

a. A controlled 20,000-cfs riverflow with normal upper pool el 95.0 and tailwater el 70.1.

b. A controlled 60,000-cfs riverflow with drawdown upper pool el 94.0 and tailwater el 79.8.

c. A controlled 80,000-cfs riverflow with drawdown upper pool el 88.0 and tailwater el 83.0 (maximum upper pool drawdown).

d. A controlled 100,000-cfs riverflow with drawdown upper pool el 89.0 and tailwater el 85.6.

e. An uncontrolled 142,000-cfs riverflow with tailwater el 91.5.

Base Experiments (Original Design)

Description

Since the lock and dam was to be constructed in an overbank area and connected to the main river channel with a man-made channel, base experiments

were conducted with original design conditions. The purposes of these experiments were to record water-surface elevations and current directions and velocities, and evaluate navigation conditions for tows entering and leaving the lock. The results of these experiments provided information and data that could be used to evaluate the effects of any modifications on water-surface elevations, current direction and velocities, and navigation conditions. The following principal features were reproduced or simulated in the model, shown in Figures 2-4:

a. A navigation lock with useable chamber dimensions of 84 ft wide by 685 ft long. The top of the lock walls were at el 103.0. A riverside, 700-ft-long ported guard wall extended upstream from the lock. The guard wall was constructed on twelve 18-ft-wide buttress-type piers placed on 54-ft centers. This design provided twelve 36-ft-wide ports and one 18-ft-wide port for the flow to move through the wall. The top of the ports were at el 78.0, and the top of the wall was at el 103.0. A landside, 650-ft-long solid guide wall extended downstream from the lock with the top of the wall at el 103.0.

b. A 423-ft-long nonnavigable gated spillway, including six 60-ft-wide tainter gates and seven 9-ft-wide piers. The dam was connected to the right bank by a 315-ft-long overflow weir with crest el 97.0. The dam was connected to the lock by a 116.3-ft-long nonoverflow cutoff wall with top el 103.0.

c. A channel with bottom el 59.0 excavated upstream from the dam to tie into the existing river channel. The right bank of the channel was in line with the right end pier of the dam and transitioned into the existing Moreau revetment along the right bank of the existing river channel.

d. A channel with bottom el 50.0 extending downstream from the lock and dam to tie into the existing river channel. The toe of the left bank of the channel was 12.0 ft to the left and parallel with the center line of the lock from sta 20+19.5 to its confluence with the existing river channel. The toe of the right bank of the channel was aligned with the right end pier of the dam from the dam to sta 5+07. From that point the right bank converged toward the lock, and at sta 22+19.5, the channel was 250 ft wide. The channel was 250 ft wide from that point to its confluence with the existing river channel. A 100-ft-wide berm with top el 68.0 ran along the right bank of the channel, and a 50-ft-wide berm with top el 76.0 ran along the left bank of the channel.

e. A trail dike off the downstream end of the riverside lock wall.

f. The revetments 143.7R, 143.0L, and Moreau. These revetments were constructed in the prototype prior to the model study to establish a channel alignment for the proposed lock and dam.

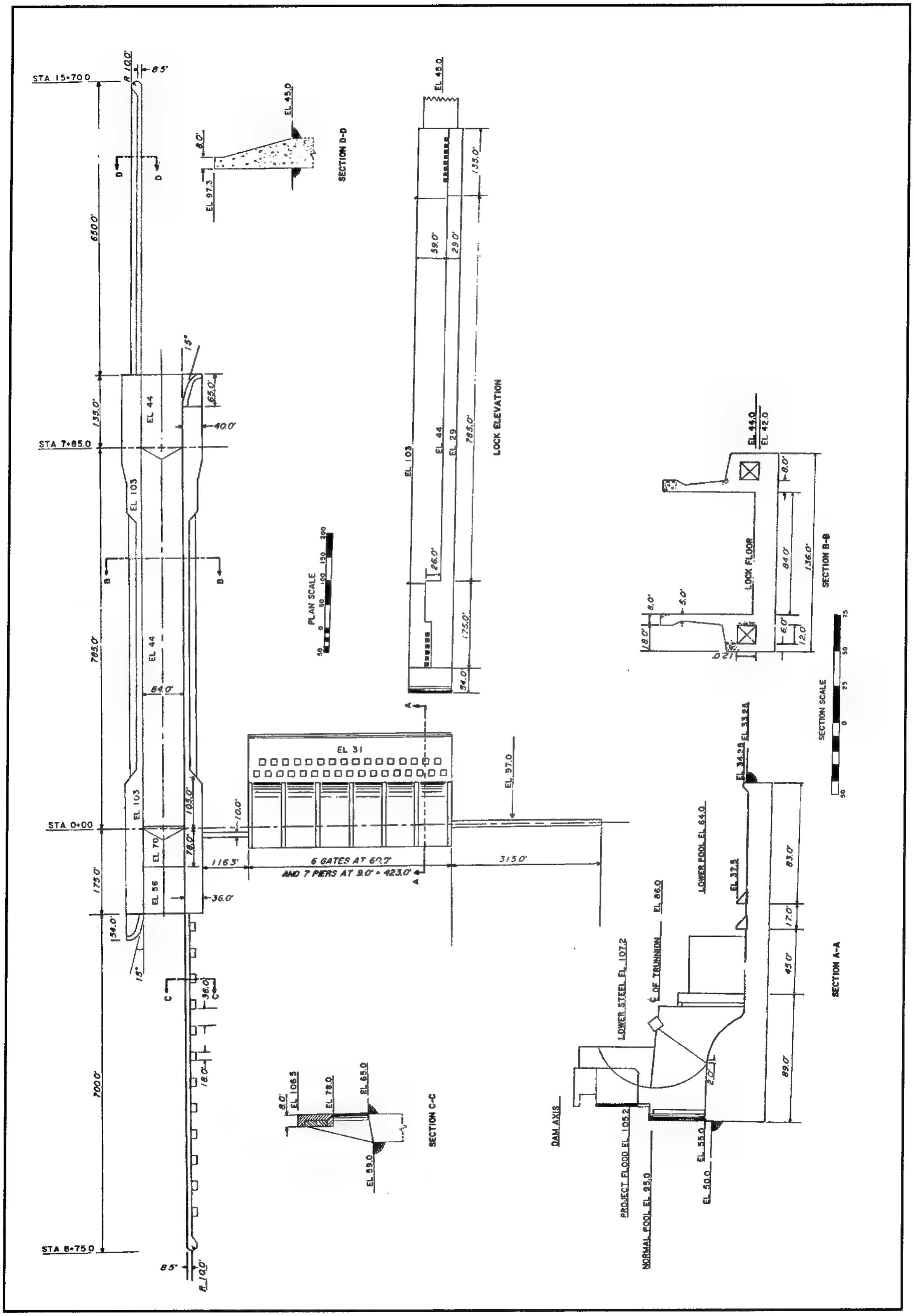


Figure 3. Plan and sections, original design

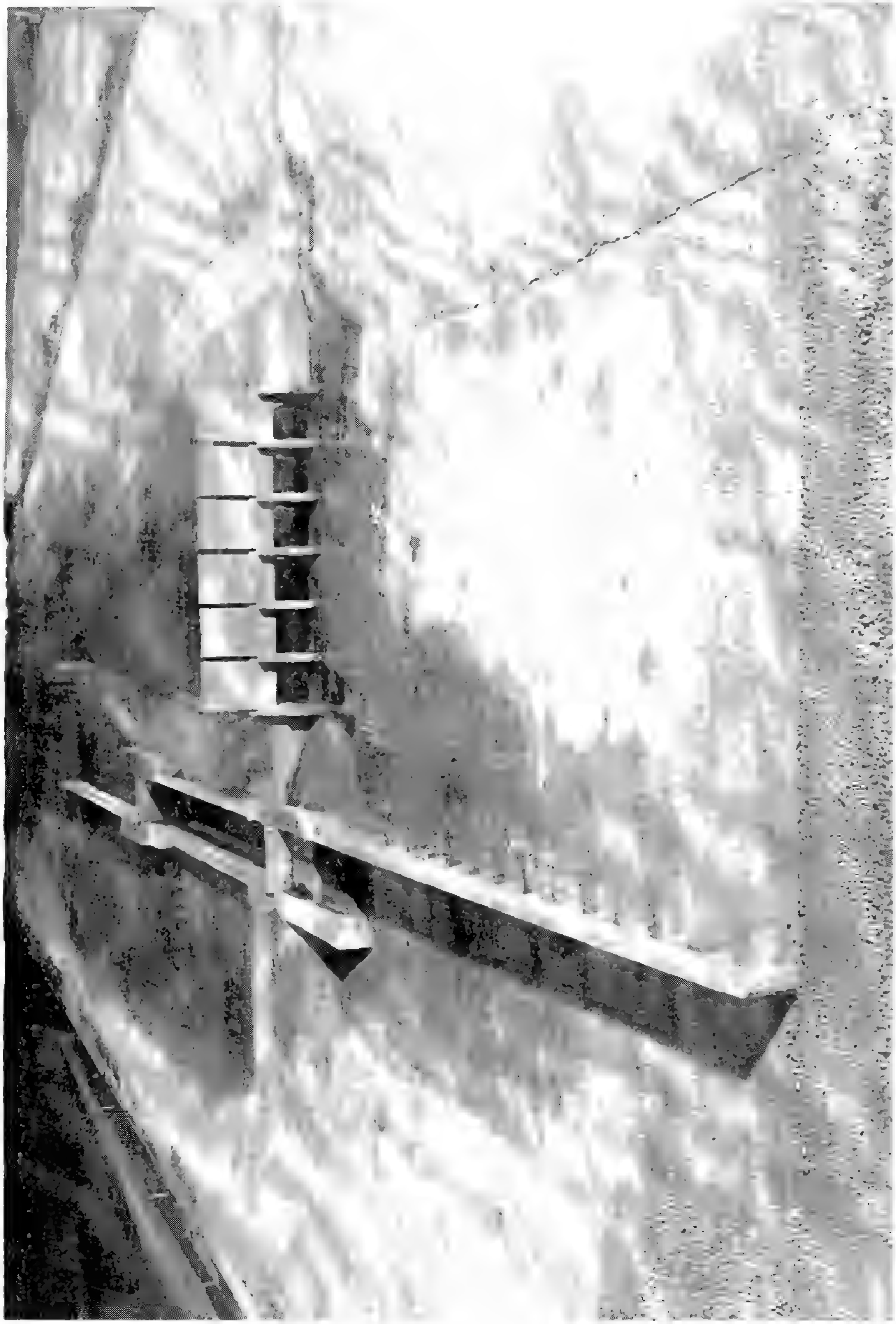


Figure 4. Model structures

Results

Water-surface elevations. Water-surface elevations obtained with original design conditions are shown in Table 1. These data show that the slope in water-surface elevation varied from less than 0.1 to 0.5 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively, and from about 0.4 to 1.0 ft per mile downstream of the dam with the 20,000- and 100,000-cfs riverflows, respectively. With an uncontrolled riverflow of 142,000 cfs, the drop across the dam was about 0.8 ft.

Table 1
Water-Surface Elevations, Original Design

	Water-Surface Elevations for Discharge in 1,000 cfs				
Gauge No.	20	60	80	100	142
1	95.0	94.5	88.6	89.9	94.1
2	95.0	94.4	88.5	89.9	94.0
3	95.0	94.3	88.4	89.6	93.6
4	95.0	94.2	88.4	89.6	93.6
5	95.0	94.2	88.4	89.6	93.6
6	95.0	94.1	88.2	89.3	93.3
7[1]	95.0	94.0	88.0	89.0	92.8
Axis of Dam					
8[1]	70.5	80.5	83.6	86.5	92.0
9	70.2	80.3	83.5	86.1	92.0
10	70.1	80.0	83.2	85.8	91.7
11	70.1	79.8	83.0	85.6	91.5
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.2	0.2	0.4	0.5
Gauges 8-11	0.4	0.8	0.7	1.0	0.6

[1] Controlled elevations.

Current directions and velocities. Current direction and velocities obtained with the original design are shown in Plates 1-4. These data show that a large counterclockwise eddy formed along the left bank revetment near the upstream end of the model, and a large counterclockwise eddy formed in the old river channel to the right of the right bank revetment with the 80,000-cfs discharge. As the riverflow increased to 100,000 cfs and the upstream cutoff dike was overtopped, flow moved down the old river channel, and downstream flow was established in the old channel and along the left bank revetment. With all riverflows evaluated, the flow generally followed the left descending bank and

moved out of the navigation channel and into the old river channel about 8,400 ft upstream. The flow reentered the navigation channel about 1,500 ft upstream of the dam near the upstream end of the esplanade. This created a strong cross-current near the upstream end of the esplanade and the upstream end of the guard wall of the lock and a large counterclockwise eddy in the forebay of the lock. The maximum velocities of the currents upstream of the dam varied from 4.0 to 6.3 fps, 6,400 ft upstream of the dam; 2.5 to 4.6 fps, 4,800 ft upstream of the dam; and 3.8 to 5.7 fps, 1,500 ft upstream of the dam with the 80,000- and 142,000-cfs riverflows, respectively.

Downstream of the dam, the currents generally followed the right bank from the dam to the downstream end of the model. Near the downstream end of the lock, the currents moved toward the left bank, moved over and around the end of the trail dike, and across the lower approach to the lock. From about sta 20+00 to the downstream end of the model, the currents were generally parallel with the channel. A small, low-velocity counterclockwise eddy formed in the lower lock approach between the trail dike and the guide wall with some riverflows. The maximum velocities of the currents in the navigation channel approaching the lock varied from 4.4 to 10.8 fps with the 20,000- and 142,000-cfs riverflows, respectively.

Navigation conditions. Navigation conditions were hazardous in the immediate upper lock approach with all riverflows due to the extreme cross-current at the upstream end of the esplanade and at the upstream end of the guard wall. The alignment of the currents was poor throughout the upper reach of the model. With the higher riverflows, there was a tendency for the tows to be grounded on the downstream end of revetment 143.0L. A downbound tow would be moved into the old river channel and to the left of the lock center line as it made its approach to the lock. As the downbound tow reduced its speed to approach the guard wall, it would be moved out of the lock approach toward the dam by the concentration of current at the end of the esplanade. An upbound tow would be pinned on the guard wall or rotated around the nose of the wall.

Navigation conditions were satisfactory for tows entering and leaving the lower lock approach with riverflows of 60,000 cfs and less. Downbound tows could move the head of the tow away from the guide wall and navigate through the channel without any major difficulty. Upbound tows could enter the lower lock approach by taking a set toward the dam to counteract the currents moving around the end of the trail dike and land on the guide wall in the protection of the trail dike without any difficulty. As the riverflow increased and the velocities of the currents moving across the lower lock approach increased, navigation conditions became difficult for tows entering and leaving the lower lock approach. A downbound tow had difficulty moving the head of the tow away from the guide wall. There was also a tendency for the currents to move the tow toward the left descending bank of the channel with some danger of the tow grounding on the bank. Upbound tows approaching the lock had some difficulty entering the lower lock approach due to the angle and velocities of the currents moving across the approach. The tow was required to take a set toward

the dam to enter the approach, and the clearance between the stern of the towboat and the left bank was minimal.

Plan A

Description

Plan A was the same as the original design except that a system of dikes was added to force the currents against the existing trench filled revetments, 143.0 L and Moreau Revetment (Figure 5). Three spur dikes were added along the right bank opposite revetment 143.0L, and five spur dikes were added along the left bank opposite Moreau Revetment. The top of the dikes were at el 97.0, which is 2.0 ft above the normal pool el of 95.0. The positions, alignments, and elevations of the dikes are listed in Figure 5.

Results

Water-surface elevations. Water-surface elevations obtained with Plan A are shown in Table 2. Compared with the original design conditions, these data show that the slope in water-surface elevations increased upstream of the dam and were about the same downstream of the dam. These data also show that the slope in water-surface elevation varied from 0.5 to 1.1 ft per mile upstream of the dam with the 80,000- and 142,000-cfs riverflows, respectively, and from about 0.8 to 1.0 ft per mile downstream of the dam with the 80,000- and the 100,000-cfs riverflows, respectively. With an uncontrolled riverflow of 142,000 cfs, the drop across the dam was about 0.8 ft.

Current directions and velocities. Current direction and velocities obtained with Plan A are shown in Plates 5-7. These data show that the spur dikes improved the alignment of the currents approaching the lock and reduced the crosscurrent near the upstream end of the esplanade and upper end of the guard wall. The currents upstream of the dam followed along 143.0L revetment and crossed to Moreau Revetment about 7,000 ft upstream of the dam. Flow along the left bank generally followed the river end of the left bank spur dikes, expanding into the old river channel downstream of the dike field and reentering the navigation channel near the upstream end of the esplanade. The dike field increased the velocities of the currents upstream of the dam. The maximum velocities of the currents upstream of the dam varied from 5.9 to 10.5 fps, 6,400 ft upstream of the dam; 4.5 to 7.4 fps, 4,800 ft upstream of the dam; and 3.9 to 6.2 fps, 1,500 ft upstream of the dam with the 80,000- and 142,000-cfs riverflows, respectively.

Navigation conditions. Navigation conditions were hazardous with all riverflows. The dike system improved the current alignment along revetment 143.0L and the Moreau Revetment, but the expansion of currents into the old river channel upstream of the lock approach and the crosscurrent at the end of

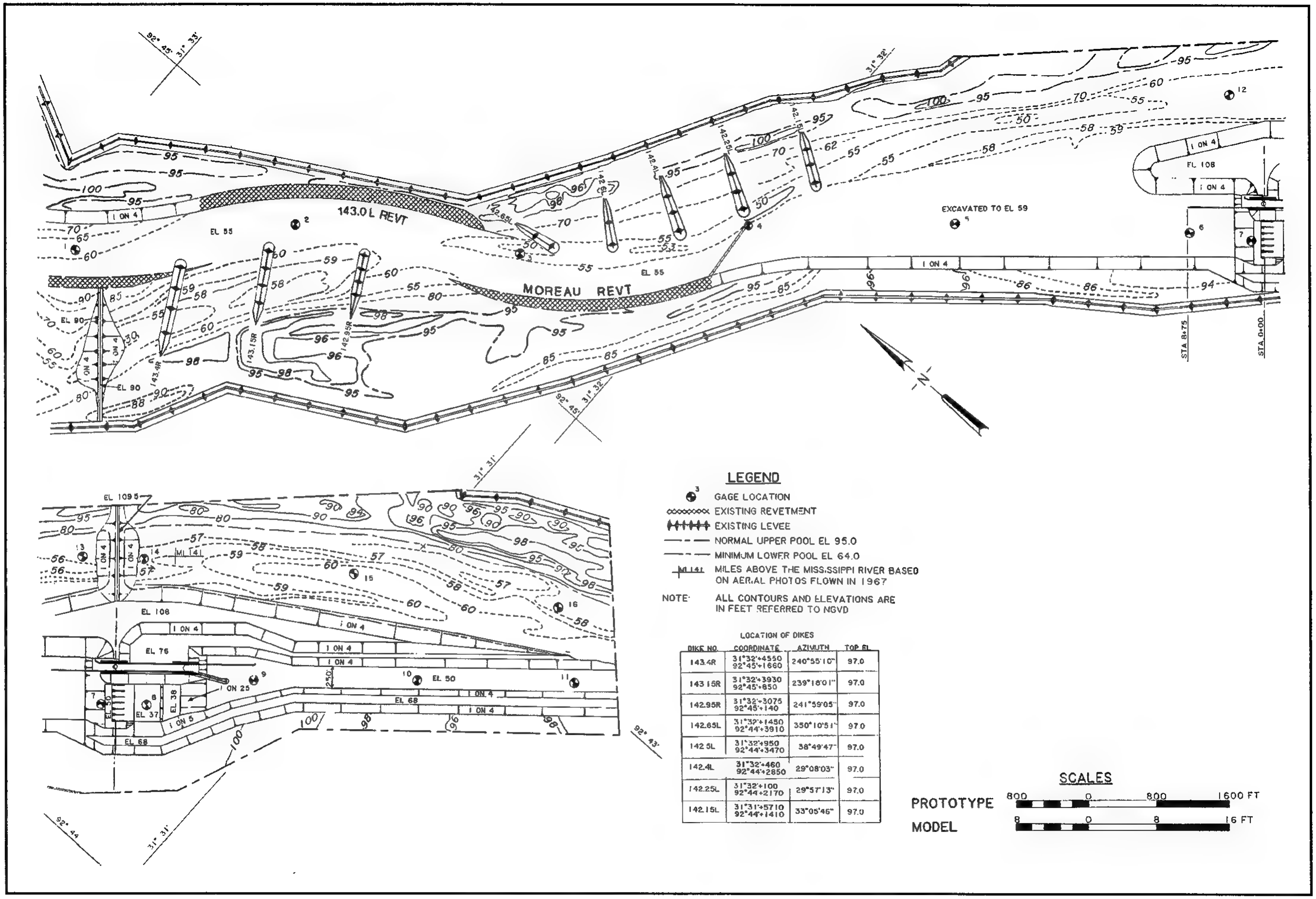


Figure 5. Plan A

Table 2 Water-Surface Elevations, Plan A			
	Water-Surface Elevations for Discharge in 1,000 cfs		
Gauge No.	80	100	142
1	89.1	90.6	95.5
2	88.7	89.9	94.2
3	88.5	89.7	94.0
4	88.3	89.4	93.5
5	88.3	89.4	93.5
6	88.2	89.2	93.3
7	88.0[1]	89.0[1]	92.8
Axis of Dam			
8	83.7	86.5	92.0
9	83.5	86.1	92.0
10	83.2	85.8	91.7
11	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile		
Gauges 1-7	0.5	0.6	1.1
Gauges 8-11	0.8	1.0	0.6

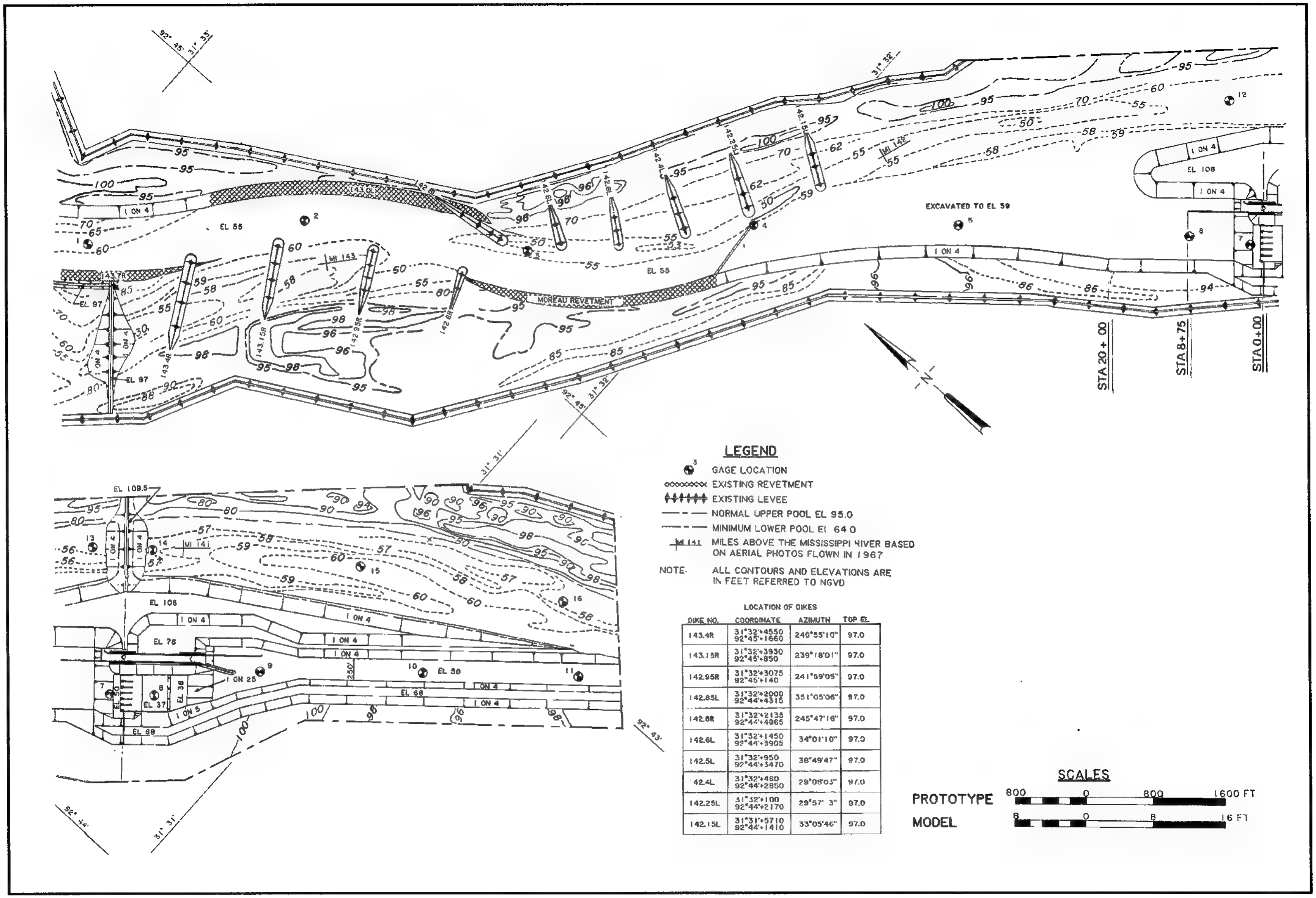
[1] Controlled elevations.

the esplanade were still present. A downbound tow making the crossing from revetment 143.0L to the Moreau Revetment would not complete the crossing before reaching the downstream end of the Moreau Revetment. The tow would then be moved into the old river channel as it made its approach to the lock. As the tow reduced its speed to approach the guard wall, it would be moved away from the lock approach by the concentrated currents moving around the upper end of the esplanade and upper end of the guard wall.

Plan A-Modified

Description

Plan A-Modified (Figure 6) was the same as Plan A except the uppermost trail dike in the left bank dike field was replaced by a spur dike, a trail dike was added to revetment 143.0L, and dike 142.8R was added at the upstream end of the Moreau Revetment. The right bank upstream of the dam was curved to tie into the Moreau Revetment.



LOCATION OF DIKES

DIKE NO.	COORDINATE	AZIMUTH	TOP EL
143.4R	31°32'+4550 92°45'+1660	240°55'10"	97.0
143.15R	31°32'+3930 92°45'+850	239°18'01"	97.0
142.95R	31°32'+3075 92°45'+140	241°59'05"	97.0
142.85L	31°32'+2000 92°44'+4315	351°05'06"	97.0
142.8R	31°32'+2135 92°44'+4865	245°47'16"	97.0
142.6L	31°32'+1450 92°44'+3905	34°01'10"	97.0
142.5L	31°32'+950 92°44'+3470	38°49'47"	97.0
142.4L	31°32'+460 92°44'+2850	29°08'03"	97.0
142.25L	31°32'+100 92°44'+2170	29°57' 3"	97.0
142.15L	31°31'+5710 92°44'+1410	33°05'46"	97.0

Figure 6. Plan A-Modified

Results

Water-surface elevations. Water-surface elevations obtained with Plan A-Modified are shown in Table 3. These data show some slight changes in water-surface elevations in the immediate vicinity of the added dikes but no significant changes through the pool compared with Plan A.

Table 3
Water-Surface Elevations, Plan A-Modified

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs: 80	100	142
1	89.1	90.6	95.2
2	88.7	90.0	94.2
3	88.4	89.4	93.4
4	88.3	89.4	93.5
5	88.3	89.4	93.6
6	88.2	89.5	93.3
7	88.0[1]	89.0[1]	92.8
Axis of Dam			
8	83.7	86.5	92.0
9	83.5	86.1	92.0
10	83.2	85.8	91.7
11	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile		
Gauges 1-7	0.5	0.6	1.0
Gauges 8-11	0.8	1.0	0.6

[1] Controlled elevations.

Current directions and velocities. Current direction and velocities obtained with Plan A-Modified are shown in Plates 8-10. These data show that the current pattern and velocities were generally the same as with Plan A. Spur dike 142.8L, which was added along the downstream end of 143.0L revetment, forced the flow against the upstream end of Moreau Revetment and increased the velocities of the currents through the reach. However, the current directions and velocities downstream of this point were generally the same as with Plan A. The crosscurrent near the upstream end of the esplanade and guard wall was generally the same as those observed with Plan A conditions.

Navigation conditions. Navigation conditions were hazardous with all riverflows. A downbound tow making the crossing from revetment 143.0L to the Moreau Revetment would cross to the downstream end of the Moreau Revetment. The tow would not be able to make the crossing for the lock approach from this position due to the currents and the short distance. Navigation conditions were generally the same as Plan A for tows entering and leaving the upper lock approach.

Plan B

Description

Plan B (Figure 7) was the same as Plan A except for the following:

a. The right bank upstream of the dam was moved riverward from sta 20+00 to the upstream end of Moreau Revetment. This moved the right bank 200 to 300 ft riverward of Moreau Revetment.

b. The dikes in the left bank dike field were shortened to provide a 600-ft-wide channel between the river end of the dikes and the right bank.

c. A 400-ft-long L-head with top el 97.0 was added to dike 142.15L. The L-head was aligned with the right bank to provide a 600-ft-wide channel .

d. Dike 142.8R was added at the upstream end of Moreau Revetment. This dike was added as part of Plan A-Modified.

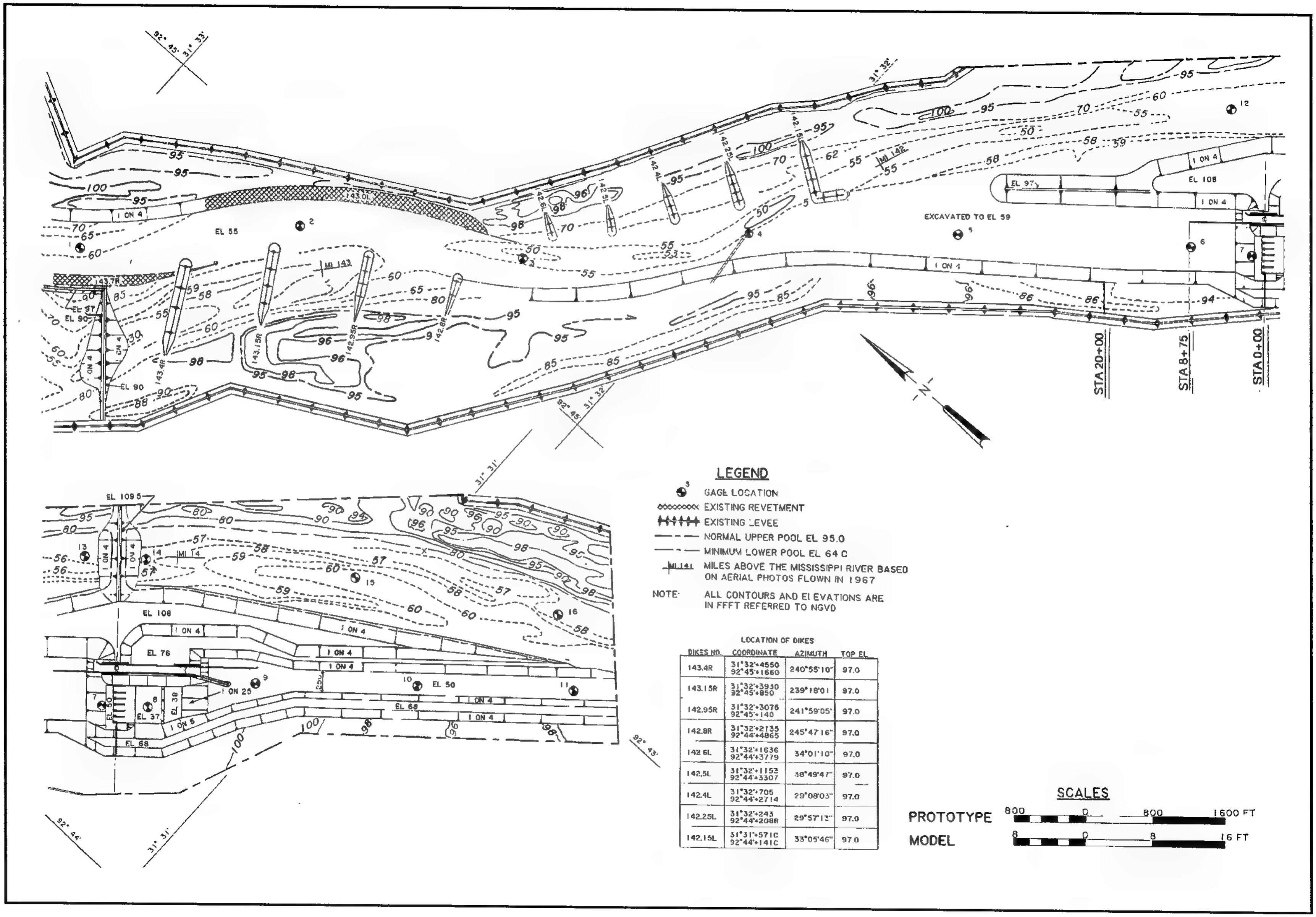
e. A dike with top el 97.0 extended upstream from the upstream end of the esplanade to sta 30+00. The dike was in line with the left bank of the lock approach, and its river face was sloped to 1V on 4H to match the left bank of the lock approach.

Results

Water-surface elevations. Water-surface elevations obtained with Plan B are shown in Table 4. These data show some local changes in water-surface elevation due to modifications in dikes and bank lines. However, there was no significant change in the slope of the water-surface through the pool compared with Plan A.

Current directions and velocities. Current direction and velocities obtained with Plan B are shown in Plates 11-13. These data show the currents are generally parallel with revetment 143.0L near the upstream end of the model, move away from the ends of the left bank dike field, and approach the lock parallel with the L-head dike and the left bank of the lock approach. There was little or no crosscurrent near the upstream end of the lock approach dike and a slight crosscurrent near the upstream end of the guard wall. A counterclockwise eddy formed between the guard wall and the left bank. The maximum velocities of the currents upstream of the dam varied from 6.5 to 9.3 fps, 6,400 ft upstream of the dam; 5.7 to 8.0 fps, 4,800 ft upstream of the dam; and 4.6 to 7.6 fps, 1,500 ft upstream of the dam with the 80,000- and 142,000-cfs riverflows, respectively.

Navigation conditions. Navigation conditions were poor with all riverflows. Due to the alignment and velocity of the currents, a downbound tow was moved toward the right bank downstream of revetment 143.0L and could not make the



LOCATION OF DIKES

DIKES NO.	COORDINATE	AZIMUTH	TOP EL
143.4R	31°32'+4550 92°45'+1660	240°55'10"	97.0
143.15R	31°32'+3930 92°45'+850	239°18'01	97.0
142.95R	31°32'+3076 92°45'+140	241°59'05"	97.0
142.8R	31°32'+2135 92°44'+4865	245°47'16"	97.0
142.6L	31°32'+1636 92°44'+3779	34°01'10"	97.0
142.5L	31°32'+1153 92°44'+3307	38°49'47"	97.0
142.4L	31°32'+705 92°44'+2714	29°08'03"	97.0
142.25L	31°32'+243 92°44'+2088	29°57'13"	97.0
142.15L	31°31'+571C 92°44'+141C	33°05'46"	97.0

Figure 7. Plan B

Table 4 Water-Surface Elevations, Plan B			
	Water-Surface Elevations for Discharge in 1,000 cfs		
Gauge No.	80	100	142
1	88.7	90.6	95.0
2	88.7	90.0	94.1
3	88.6	89.8	93.9
4	88.4	89.5	93.5
5	88.5	89.4	93.4
6	88.2	89.2	93.3
7	88.0[1]	89.0[1]	92.8
Axis of Dam			
8	83.8	86.5	92.0
9	83.5	86.1	92.0
10	83.2	85.8	91.7
11	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile		
Gauges 1-7	0.3	0.6	0.9
Gauges 8-11	0.9	1.0	0.6

[1] Controlled elevations.

crossing back to the lock approach. However, a downbound tow could start flanking near the downstream end of revetment 143.0L, hold its stern near the river end of the left bank dike field, start driving near the downstream end of the L-head dike, and enter the lock approach at a safe speed. There was some cross-current at the upstream end of the channel dike and near the upstream end of the guard wall, but it was not an extreme problem for a downbound tow. An upbound tow could break free of the guard wall, drive toward the center of the channel, and move upstream without any major difficulty.

Plan C

Description

Plan C (Figure 8) was suggested by the Vicksburg District to reduce the amount of stone required to build dikes. The alignment is the same as Plan B except for the following:

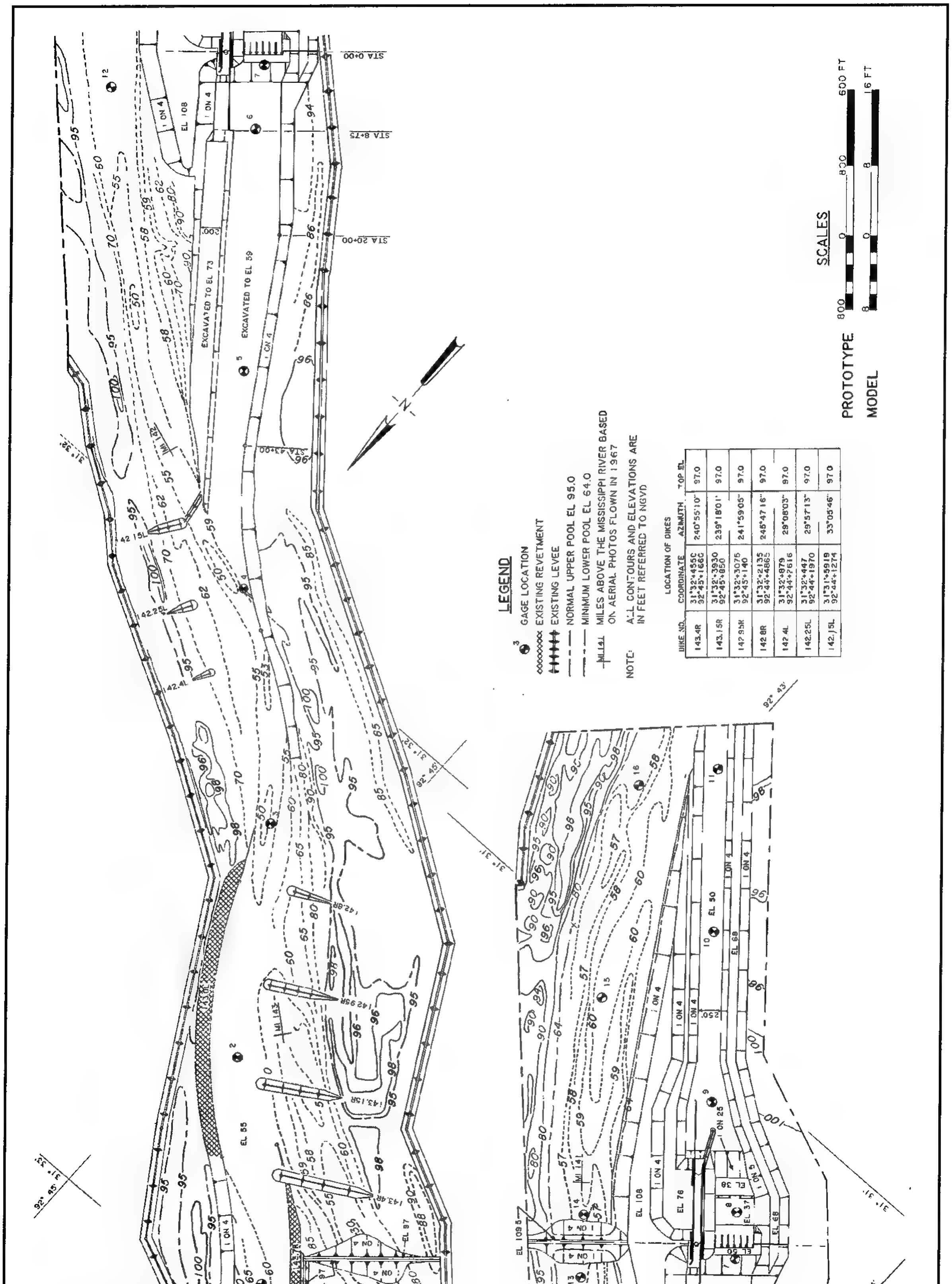


Figure 8. Plan C

a. The right bank upstream of sta 20+00 was moved riverward. The alignment of the bank was straight from sta 20+00 to sta 43+00 and then curved to the left to tie into the upstream end of Moreau Revetment.

b. The dike extending upstream from the esplanade was removed, and the left bank of the lock approach was realigned. A 200-ft-wide excavation with bottom el 73.0 extended upstream from the guard wall to tie into the existing river channel. The remainder of the channel was excavated to el 59.0, the same as Plan B.

c. Dikes 142.6L and 142.5L were removed.

d. Dikes 142.4L, 142.25L, and 141.15L were shortened to provide a 600-ft-wide channel between the river end of the dikes and the right bank.

e. A submerged dike with top el 73.0 extended from the river end of dike 142.15L to the upstream end of the 200-ft-wide approach channel.

Results

Water-surface elevations. Water-surface elevations obtained with Plan C are shown in Table 5. These data show the slope in water-surface elevations varied from 0.5 to 0.9 ft per mile upstream of the dam with the 80,000- and 142,000-cfs riverflows, respectively, and from 0.8 to 1.0 ft per mile downstream of the dam with the 80,000- and 142,000-cfs riverflows, respectively.

Current directions and velocities. Current direction and velocities obtained with Plan C are shown in Plates 14-16. These data show that the currents were generally parallel with revetment 143.0L near the upstream end of the model, followed the river end of the left bank dikes, and moved across the upstream end of the lock approach channel toward the dam. A large counterclockwise eddy formed in the old river channel near the lock approach channel. The maximum velocities of the currents upstream of the dam varied from 7.1 to 10.0 fps, 6,400 ft upstream of the dam; 5.2 to 7.5 fps, 4,800 ft upstream of the dam; and 5.6 to 7.7 fps, 1,500 ft upstream of the dam with the 80,000- and 142,000-cfs riverflows, respectively.

Navigation conditions. Navigation conditions were unsatisfactory for all riverflows. A downbound tow could drive along revetment 143.0L near the upstream end of the model, turn toward the left bank dikes, and align with the lock approach about 2,500 ft upstream of the guard wall. However, as the tow reduced speed to approach the guard wall, the current moving across the approach moved the tow away from the guard wall. The tow could drive through the currents but would approach the guard wall too fast and could strike the wall with considerable force. An upbound tow could break free of the guard wall, take a set toward the left bank, and leave the forebay without any major

Table 5
Water-Surface Elevations, Plan C

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs		
	80	**100**	**142**
1	89.2	90.6	95.1
2	88.8	90.0	94.2
3	88.7	89.8	94.0
4	88.5	89.6	93.7
5	88.3	89.4	93.5
6	88.1	89.1	93.1
7	88.0[1]	89.0[1]	92.8
Axis of Dam			
8	83.8	86.5	92.0
9	83.6	86.1	92.0
10	83.3	85.8	91.7
11	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/min		
Gauges 1-7	0.5	0.6	0.9
Gauges 8-11	0.9	1.0	0.6

[1] Controlled elevations.

difficulty. However, as the tow cleared the lock approach, it was moved toward the center of the channel by the currents moving across the approach.

Plan D

Description

Plan D (Figures 9 and 10) was the same as Plan C with the following exceptions:

a. The channel approaching the dam was raised to el 65.

b. A dike with top el 97.0 extended upstream from the upstream end of the esplanade to sta 42+70. The dike was in line with the left bank of the lock approach and its river face was sloped to 1V on 4H to match the left bank of the lock approach.

c. Dike 142.15L was shortened and an L-head with top el 97.0 was added to its end to align with the dike extending upstream from the esplanade.

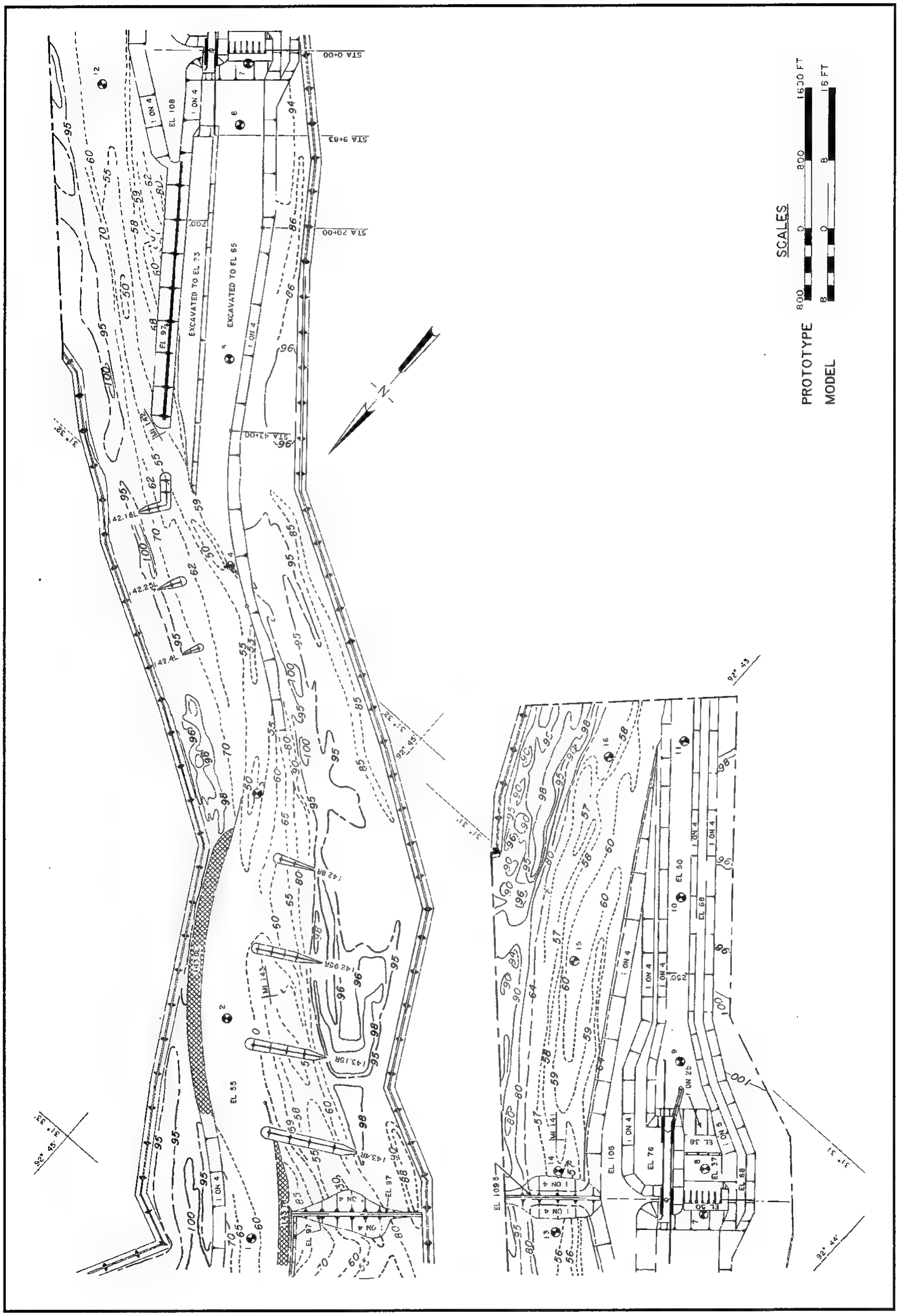


Figure 9. Plan D

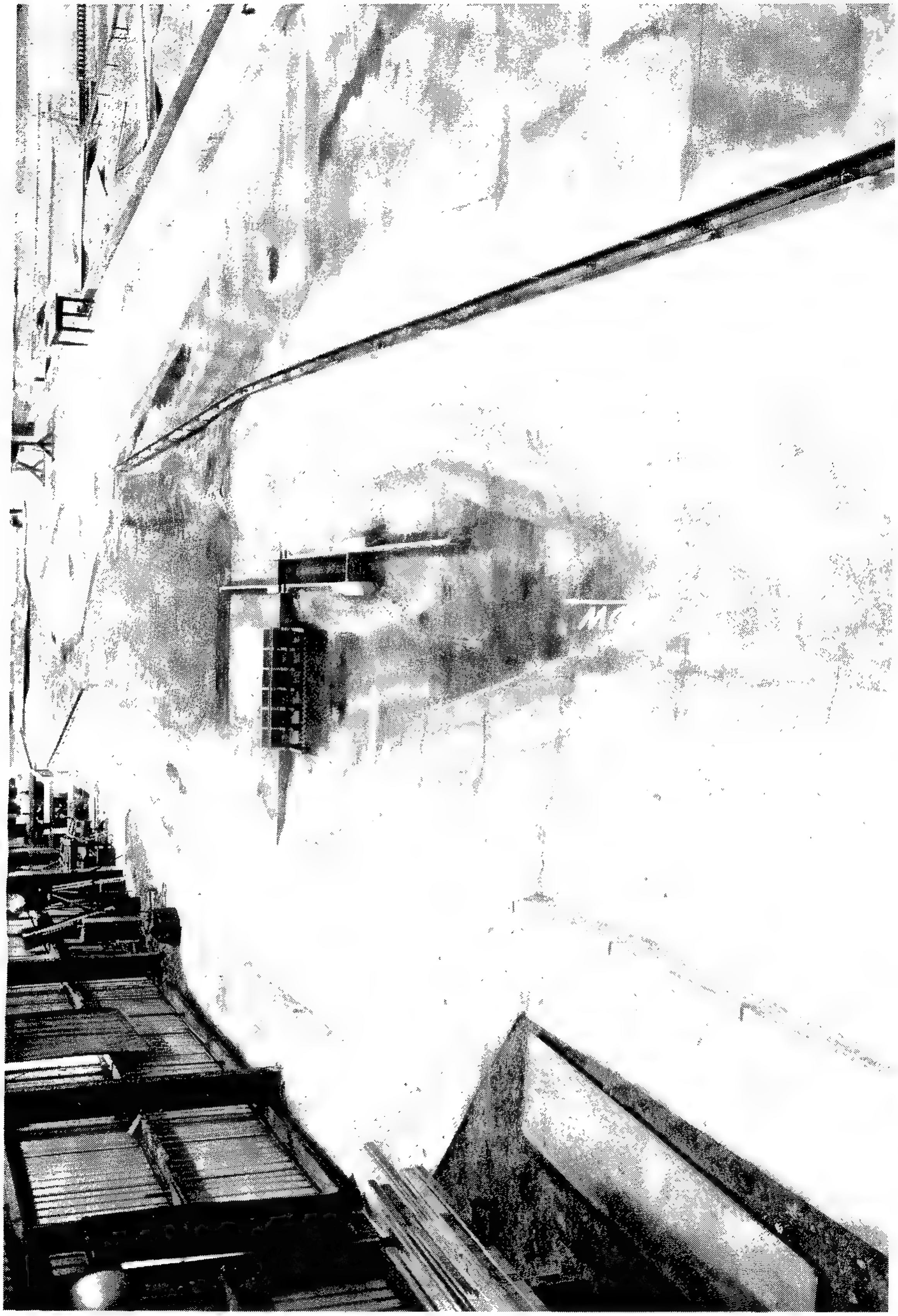


Figure 10. Plan D structures

d. The guard wall was extended upstream to sta 9+83 (about 100 ft) by adding two ports and two piers.

Results

Preliminary experiments indicated navigation conditions were satisfactory for all riverflows through 100,000 cfs. Therefore, data were recorded for the full range of riverflows from 20,000 through 142,000 cfs.

Water-surface elevations. Water-surface elevations obtained with Plan D are shown in Table 6. These data show that raising the channel approaching the dam increased the slope in water-surface elevations upstream of the dam compared with Plan C. The slope in water-surface elevations varied from less than 0.1 to 1.3 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The largest increase was 0.4 ft per mile with the 100,000- and 142,000-cfs riverflows. The slope in water-surface elevation downstream of the dam was generally the same as with Plan C. The drop through the gated dam was 0.8 ft with the 142,000-cfs uncontrolled riverflow.

Table 6
Water-Surface Elevations, Plan D

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs				
	20	60	80	100	142
1	95.1	94.6	89.8	91.5	96.1
2	95.1	94.4	89.8	90.9	95.2
3	95.0	94.3	89.3	90.8	95.0
4	95.0	94.3	89.1	90.5	94.6
5	95.0	94.2	88.6	89.8	94.0
6	95.0	94.1	88.1	89.2	93.3
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	92.8
Axis of Dam					
8	70.5	80.5	83.7	86.5	92.0
9	70.2	80.3	83.5	86.1	92.0
10	70.1	80.0	83.2	85.8	91.8
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.2	0.7	1.0	1.3
Gauges 8-11	0.4	0.8	0.8	1.0	0.6

[1] Controlled elevations.

Current directions and velocities. Current direction and velocities obtained with Plan D are shown in Plates 17-21. These data show that the currents were generally parallel with revetment 143.0L near the upstream end of the model, moved along the river end of the left bank dikes, and approached the lock parallel with the left bank of the lock approach. A large counterclockwise eddy formed in the forebay of the lock between the guard wall and the left bank. The maximum velocities of the currents upstream of the dam with riverflows of 80,000 cfs and above were slightly higher near the dam compared with Plan C and varied from 6.9 to 10.0 fps, 6,400 ft upstream of the dam; 5.8 to 8.3 fps, 4,800 ft upstream of the dam; and 6.0 to 8.7 fps, 1,500 ft upstream of the dam with the 80,000- and 142,000-cfs riverflows, respectively. With the 20,000- and 60,000-cfs riverflows, the maximum velocities of the currents varied from 1.4 to 3.4 fps, 6,400 ft upstream of the dam; 1.2 to 3.3 fps, 4,800 ft upstream of the dam; and 1.0 to 8.7 fps, 1,500 ft upstream of the dam.

Navigation conditions. Navigation conditions were good with all riverflows through 100,000 cfs. A downbound tow could drive along the center of the navigation channel, align with the lock approach two tow lengths upstream of the guard wall, and start reducing speed to approach the guard wall at a safe speed. A downbound tow navigating along the left bank and entering the excavated channel along the left bank longitudinal dike could start a flanking maneuver as soon as it cleared the upstream end of the dike and approach the guard wall at a safe speed. With some riverflows, there was a tendency for the head of the tow to be moved toward the left bank and out of alignment with the lock chamber as the tow approached the lock. When the riverflow increased to 142,000 cfs, the crosscurrent near the upstream end of the guard wall increased to a point that it caused some problems for navigation. A downbound tow could drive along the left bank, align with the guard wall, start reducing speed two tow lengths upstream of the wall, and approach the guard wall at a safe speed. However, as the tow entered the lock forebay, the head of the tow was pulled toward the guard wall with considerable force due to the crosscurrent at the upstream end of the guard wall. With riverflows through 100,000 cfs, upbound tows could break free of the guard wall and drive upstream along the left bank of the approach without any difficulty. However, as the tow moved past the upstream end of the left bank longitudinal dike, the tow was moved toward the center of the channel by the crosscurrent near the end of the dike. The tow was able to maintain control with a minimum of maneuvering and continue upstream. With a riverflow of 142,000 cfs, an upbound tow had difficulty breaking free of the guard wall, and there was a tendency for the tow to be rotated around the upstream end of the wall. The tow was required to take a large set toward the left bank to counteract the crosscurrent near the upstream end of the guard wall.

In a effort to improve navigation conditions, preliminary experiments were conducted with several modifications to the guard wall. Experiments were conducted with the top of the ports in the upstream 200 ft of the wall lowered 5 ft to el 73.0, the ports in the upstream 200 ft of the guard wall closed, and the top of the ports in the upstream 400 ft of the wall lowered 5 ft to el 73.0. The experiments showed that closing the ports partially or completely reduced the maneuvering required for an upbound tow to move away from the guard wall but

did not improve navigation conditions for downbound tows approaching the guard wall.

Plan E

Description

During the course of this study, a movable-bed model study of Lock and Dam No. 3 was being conducted to predict scour and fill with the various alignment plans developed in the navigation model. Plan E was a modification of Plan D that was developed in the movable-bed model to maintain a navigation channel from the upper end of the model into the lock. Plan E (Figure 11) was the same as Plan D with the following changes:

a. The longitudinal dike extending upstream from the upstream end of the esplanade was realigned and extended upstream to tie into the existing left bank of the old channel. The dike moved toward the right bank about 100 ft at sta 42+70.

b. The right bank was realigned from sta 20+00 to the upstream end of Moreau Revetment. At sta 48+00, the right bank was moved landward about 200 ft to provide a minimum channel width of 600 ft.

c. The channel was remolded to the bed configuration predicted by the movable-bed model.

Results

Water-surface elevations. Water-surface elevations obtained with Plan E are shown in Table 7. These data show a large increase in the slope in water-surface elevations through the upper pool compared with Plan D. Most of the change can be attributed to the changes in the elevation of the bed and reduced cross-sectional area between the two plans. The slope in water-surface elevations varied from less than 0.1 to 2.5 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The largest increase was 1.4 ft per mile with the 100,000-cfs riverflow. The drop through the dam was 0.8 ft with the 142,000-cfs uncontrolled riverflow. The slope in water-surface elevations downstream of the dam was generally the same.

Current directions and velocities. Current direction and velocities obtained with Plan E are shown in Plates 22-26. These data show that the currents were generally parallel with the left descending bank from the upstream end of the model to the lock forebay. A counterclockwise eddy formed in the upper lock approach along the left bank near the lock chamber. Generally the highest velocities were near the center of the channel with the velocities along the left bank slightly lower. The maximum velocities of the currents upstream of the dam

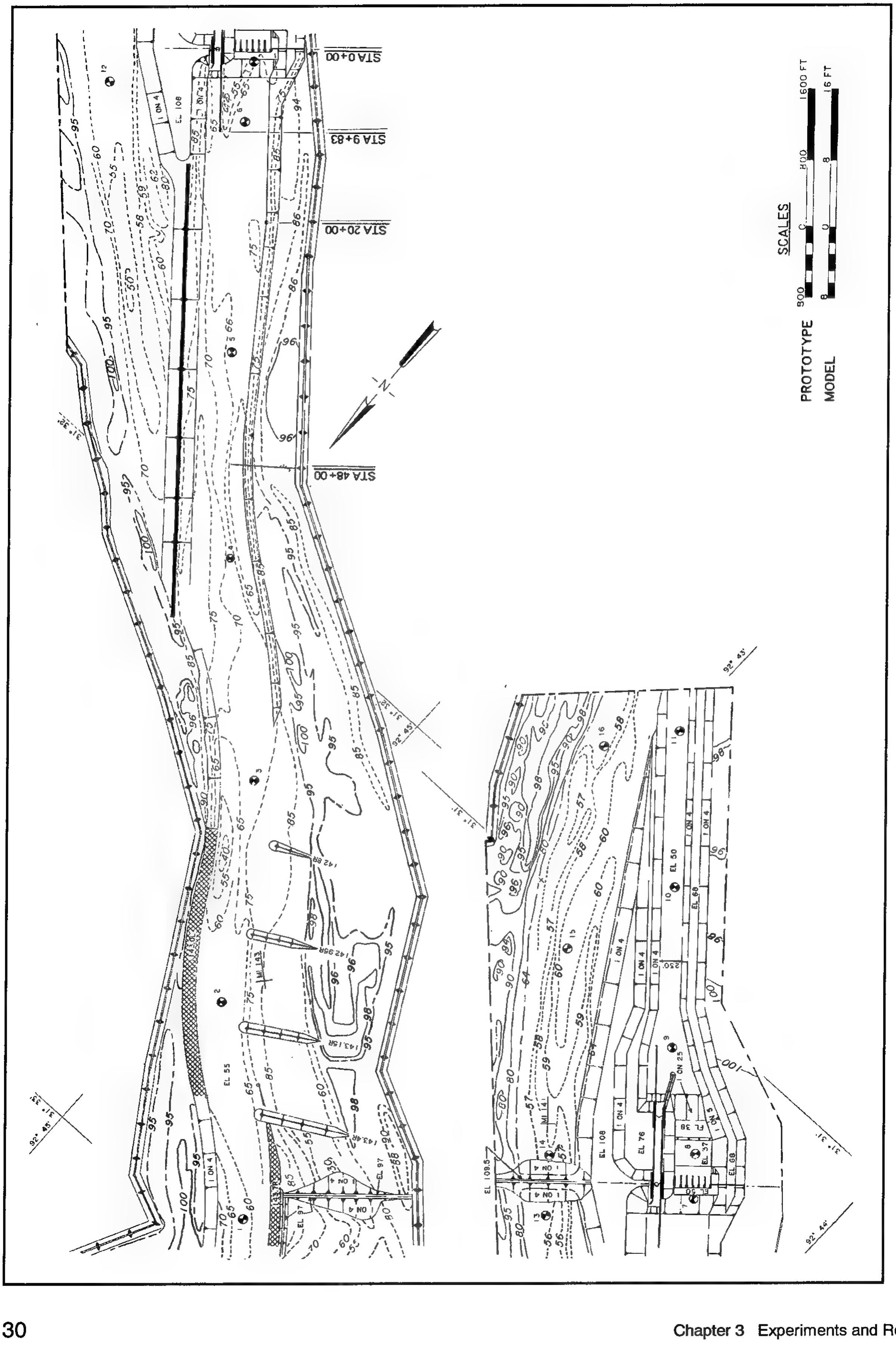


Figure 11. Plan E

Table 7
Water-Surface Elevations, Plan E

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs				
	20	60	80	100	142
1	95.0	95.3	92.9	95.0	99.1
2	95.0	95.1	92.5	94.5	98.4
3	95.0	95.0	92.1	94.1	97.9
4	95.0	94.7	91.3	93.1	97.1
5	95.0	94.4	89.9	91.5	95.3
6	95.0	94.0	88.2	89.5	93.6
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	92.8
Axis of Dam					
8	70.5	80.5	83.9	86.5	92.0
9	70.3	80.2	83.6	86.2	92.0
10	70.2	80.0	83.3	85.8	91.8
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.5	1.2	2.4	2.5
Gauges 8-11	0.4	0.8	1.0	1.0	0.6

[1] Controlled elevations.

varied from 1.5 to 8.7 fps, 6,400 ft upstream of the dam; 1.4 to 10.3 fps, 4,800 ft upstream of the dam; and 1.1 to 9.5 fps, 1,500 ft upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively.

Navigation conditions. Navigation conditions at riverflows of 80,000 cfs and above were hazardous for downbound tows. The sailing line for a downbound tow was along revetment 143.0L, crossing to the right bank in the vicinity of Moreau Revetment, and then crossing to the left bank to make the approach to the lock along the left bank longitudinal dike. At riverflows of 80,000 cfs and above, the tow was crossing high-velocity currents to align with the dike and make its approach to the lock. To make the crossing, the tow was required to drive faster than the currents and could not align with the dike and the upstream guard wall until it was about one tow length upstream of the guard wall. At this point the tow was flanking against high-velocity currents and could not reduce its speed to a safe speed to approach the guard wall. There was a tendency for the currents to rotate the head of the tow into the upper end of the guard wall with considerable force due to the alignment of the currents. Upbound tows experienced difficulty moving the head of the tow off the guard wall due to the angle and velocity of the currents. However, if the tow could

move the head of the tow away from the guard wall and it had sufficient power to navigate against the high-velocity currents, it could move upstream along the longitudinal dike without any major difficulty.

Plan F

Description

Preliminary experiments were conducted in the navigation model to develop a realignment that would provide satisfactory navigation conditions for tows entering and leaving the upper lock approach. Upon approval of the realignment by the Vicksburg District, experiments were conducted in the movable-bed model to estimate the scour and fill that would occur with the new alignment, and those channel depths were molded in the navigation model as part of Plan F. A channel configuration and dike plan was also developed in the movable-bed model to minimize maintenance dredging downstream of the dam. This configuration and dike scheme was also installed in the navigation model as part of Plan F. Plan F (Figure 12) is the same as Plan E with the following exceptions:

a. The levee along the left descending bank near the downstream end of revetment 143.0L was set back approximately 300 ft. The downstream end of revetment 143.0L was removed, and the left bank was curved to tie into the longitudinal dike extending upstream from the lock esplanade.

b. The right bank was realigned from sta 20+00 to the upstream end of Moreau Revetment. At sta 48+00 the right bank was moved riverward about 200 ft. This provided a channel width of about 500 ft. The right bank alignment was the same as Plan D alignment.

c. The channel upstream and downstream of the dam was molded to the bed configuration predicted by the movable-bed model.

d. The existing 650-ft-long guide wall that extended downstream from the landside lock wall was removed and replaced with a 650-ft-long solid guard wall extending downstream from the river wall of the lock.

e. The separation between the inside face of the riverward lock wall and the riverward face of the dam pier was decreased from 157.25 to 76 ft by moving the dam.

f. The left bank downstream of the lock was reshaped from the lock to sta 28+10. This provided a 150-ft-wide channel landward of the lower guard wall that extended downstream to sta 25+10.

g. The right bank downstream of the dam was realigned from the dam downstream to sta 25+60.

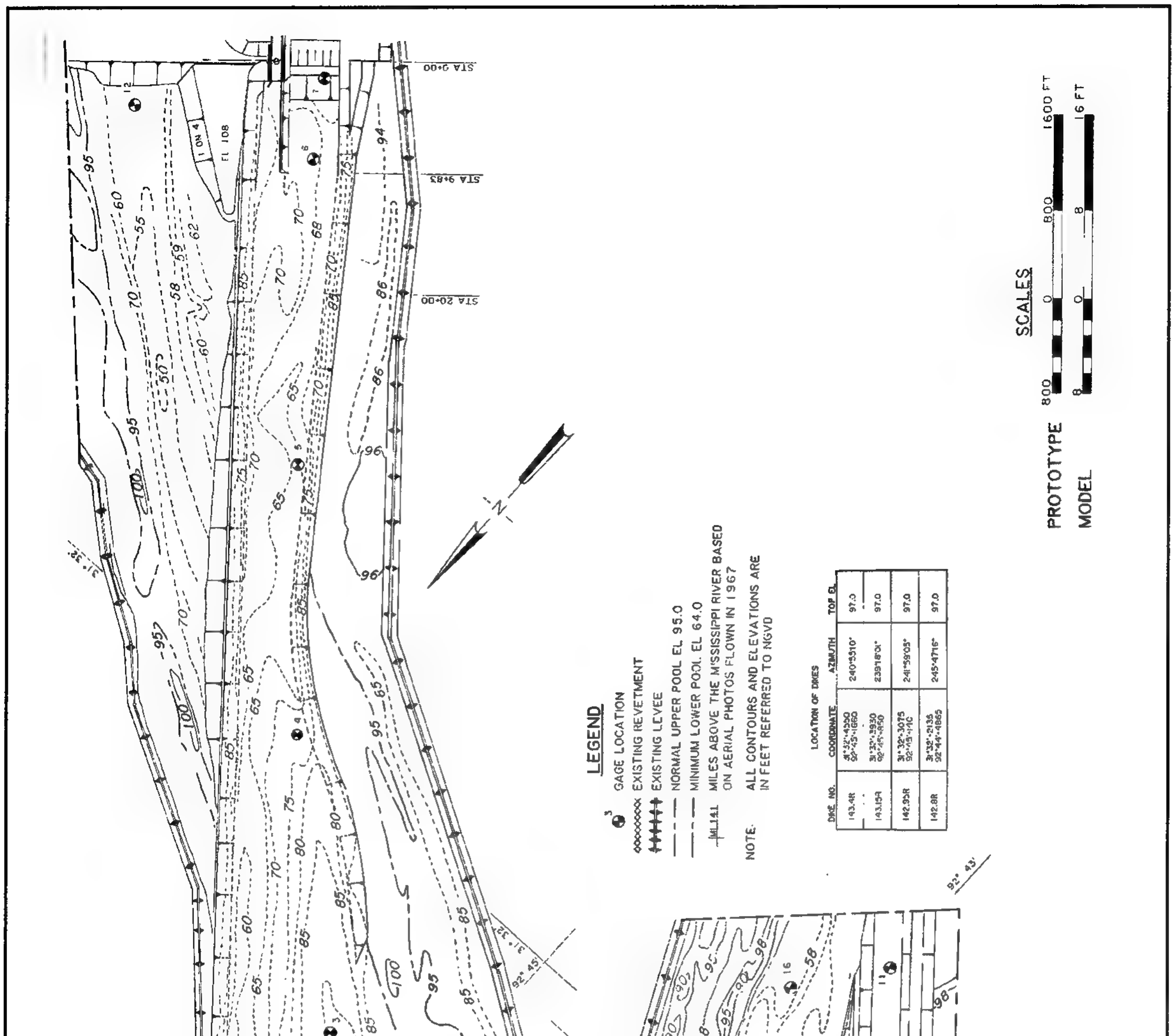


Figure 12. Plan F

h. A spur dike with top el 65.0 was added along the right bank at sta 11+40. The spur dike was directed upstream with the river end of the dike upstream of the land end of the dike.

i. A 400-ft-long trail dike with top el 64.0 extended downstream from the downstream end of the lower guard wall.

Results

Water-surface elevations. Water-surface elevations obtained with Plan F are shown in Table 8. These data show a significant decrease in the slope in water-surface elevations upstream of the dam compared with Plan D, while the slope in water-surface elevations downstream of the dam increased compared with Plan D. The slope in water-surface elevations varied from less than 0.1 to 1.6 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The slope in water-surface elevation downstream of the dam varied from less than 0.1 to 1.7 ft per mile with the 20,000- and 100,000-cfs riverflow, respectively. The drop through the dam was 0.5 ft with the 142,000-cfs uncontrolled riverflow.

Table 8
Water-Surface Elevations, Plan F

	Water-Surface Elevations for Discharge in 1,000 cfs				
Gauge No.	20	60	80	100	142
1	95.0	94.7	90.9	92.6	97.3
2	95.0	94.6	90.7	92.3	96.8
3	95.0	94.5	89.8	91.4	96.2
4	95.0	94.2	89.1	90.4	95.1
5	95.0	94.1	88.6	89.8	94.4
6	95.0	94.0	88.2	89.3	93.9
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	93.3
Axis of Dam					
8	70.5	81.0	84.4	87.1	92.8
9	70.3	80.0	83.1	85.6	91.5
10	70.2	79.9	83.2	85.7	91.6
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.3	1.2	1.4	1.6
Gauges 8-11	0.4	1.3	1.6	1.7	1.4

[1] Controlled elevations.

Current directions and velocities. Current direction and velocities obtained with Plan F are shown in Plates 27-31. These data show that the currents upstream of the dam were generally parallel with the left descending bank from the upstream end of the model to the lock forebay. The maximum velocities of the currents upstream of the dam varied from 1.3 to 9.5 fps, 6,400 ft upstream of the dam; 1.6 to 10.8 fps, 4,800 ft upstream of the dam; and 1.1 to 10.0 fps, 1,500 ft upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The maximum velocities of the currents in the immediate forebay of the lock varied from less than 1.0 to 9.7 fps with the 20,000- and 142,000-cfs riverflows. The flow moved through the dam parallel with the lock and the right bank from the dam to the downstream end of the guard wall, then toward the left bank. Some flow moved over the top of the trail dike, but a large counterclockwise eddy formed in the lower lock approach between the trail dike and the left bank. A maximum upstream eddy velocity of 3.8 fps occurred with the 142,000-cfs riverflow. The velocities of the currents in the navigation channel approaching the dam varied from 5.9 to 12.1 fps with the 20,000- and 142,000-cfs riverflows, respectively. These velocities were considerably higher than those measured with previous plans.

Navigation conditions. Navigation conditions were satisfactory for tows entering and leaving the upper lock approach with riverflows of 60,000 cfs and below. Downbound tows could drive close along the left bank from the upstream end of the model to a point two or three tow lengths upstream of the upstream end of the guard wall, start flanking to reduce speed, and approach the guard wall at a safe speed. As the tow moved into the lock forebay and the head of the tow approached the midpoint of the guard wall, there was a tendency for the head of the tow to be pulled into the guard wall. An upbound tow could move the head of the tow away from the guard wall and navigate upstream along the longitudinal dike without any major difficulty. As the riverflow increased to 80,000 cfs, the velocities of the currents that tows would encounter doubled compared with 60,000 cfs. The alignment of the currents for tows entering and leaving the upper lock approach was good, but the velocities of the currents increased to a point that tows would have some difficulty maintaining control. Downbound tows could drive along the left descending bank to a point two or three tow lengths upstream of the guard wall, start flanking to reduce speed, and enter the lock forebay with good alignment. However, it was difficult to maintain a safe speed approaching the guard wall. As the tow moved into the lock forebay and the head of the tow approached the midpoint of the guard wall, there was a tendency for the head of the tow to strike the guard wall with considerable force. An upbound tow had difficulty moving the head of the tow away from the guard wall due to the high- velocity currents. If the tow had sufficient power to move the head of the tow away from the wall and take a 5- to 10-deg set toward the left descending bank, it could navigate upstream along the left bank without any major difficulty.

Navigation conditions were satisfactory for tows entering and leaving the lower lock approach with riverflows of 60,000 cfs and below. As a downbound tow left the lower lock approach, there was a tendency for the tow to be moved toward the left bank, and some maneuvering was required for the tow to make

the turn into the navigation channel. Upbound tows could approach the lock, turn into the lock approach, and land on the guard wall without any major difficulty. However, with riverflows of 80,000 cfs and above, tows would encounter high-velocity currents, and tows with normal or low power may have some difficulty navigating the reach.

Plan G

Description

Plan G (Figure 13) was similar to Plan F except the upstream channel was remolded to represent a channel constructed along the same alignment as Plan F prior to any scour or fill. The right bank alignment downstream of the dam was designed in the large-scale structure model to provide the best energy dissipation and to control scouring of the bed and bank. The bank alignment was incorporated into this plan to evaluate its effect on navigation. The major differences between Plan G and Plan F were as follows:

a. That part of the navigation channel upstream of the dam that followed the existing river channel was remolded to existing bed contours.

b. A channel with bottom el 64.0 was excavated upstream from the lock and dam structure to tie into the existing river channel. A 256-ft-wide berm with top el 73.0 extended upstream along the left bank from the upstream end of the guard wall to the upstream end of the channel.

c. Dikes 142.95R and 142.8R were extended about 250 and 600 ft, respectively, to maintain a 600-ft-wide channel between the river end of the dikes and the left descending bank.

d. The separation between the inside face of the riverward lock wall and the riverward face of the dam pier was increased from 76 to 157.25 ft by moving the dam. This moved the dam back to the original location.

e. The right bank downstream of the dam and channel excavation was realigned from the dam to about sta 9+20. This alignment reflects the bank alignment designed in the large-scale structure model.

Results

Water-surface elevations. Water-surface elevations obtained with Plan G are shown in Table 9. These data show that the slope in water-surface elevation upstream of the dam was generally the same as with Plan F. The slope in water-surface elevations varied from less than 0.1 to 1.6 ft per mile upstream of the dam with the 20,000- and the 142,000-cfs riverflows, respectively. The slope in water-surface elevation downstream of the dam varied from 0.7 to 1.8 ft per mile with the 20,000- and 100,000-cfs riverflows, respectively. The drop through the dam was 0.4 ft with the 142,000-cfs uncontrolled riverflow.

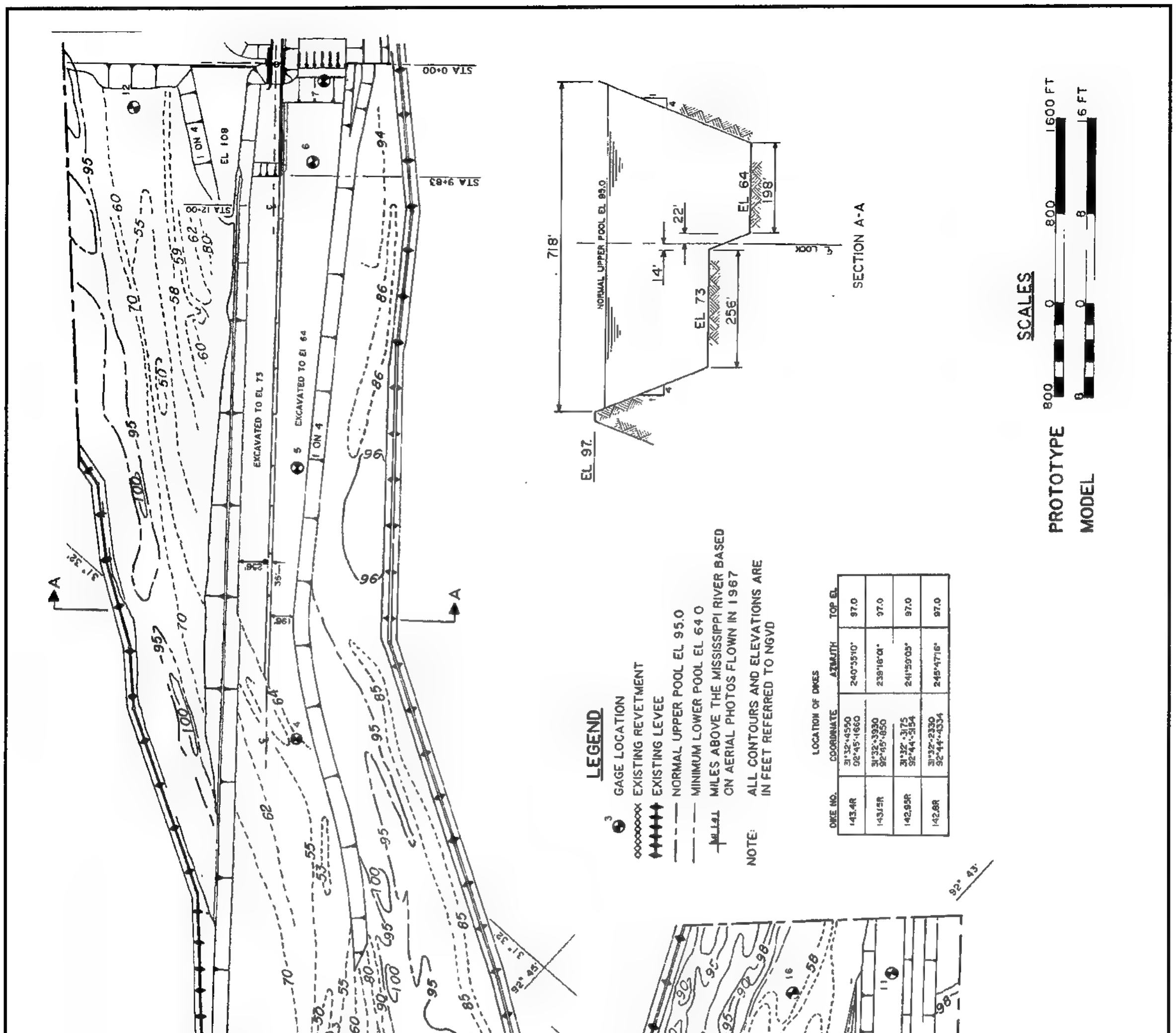


Figure 13. Plan G

Table 9
Water-Surface Elevations, Plan G

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs				
	20	60	80	100	142
1	95.1	94.8	90.4	92.1	97.1
2	95.1	94.7	90.2	92.8	95.5
3	95.1	94.5	89.5	91.0	95.5
4	95.0	94.5	89.6	90.0	95.6
5	95.0	94.2	88.5	89.5	93.8
6	95.0	94.2	88.2	89.3	93.7
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	93.0
Axis of Dam					
8	70.7	81.0	84.4	87.2	92.6
9	70.2	80.0	83.1	85.6	91.4
10	70.2	79.9	83.1	85.7	91.6
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.3	1.0	1.2	1.6
Gauges 8-11	0.7	1.3	1.6	1.8	1.7

[1] Controlled elevations.

Current directions and velocities. Current direction and velocities obtained with Plan G are shown in Plates 32-36. These data show that the currents were generally parallel to the left descending bank from the upstream limits of the model to the lock. A large clockwise eddy formed along the right bank downstream of dike 142.8R with all riverflows. With the 20,000-cfs riverflow, a large counterclockwise eddy formed in the lock approach. The eddy extended upstream of the guard wall about 1,500 ft. The maximum velocities of the currents upstream of the dam varied from 1.7 to 10.8 fps, 6,400 ft upstream of the dam; 1.8 to 12.9 fps, 4,800 ft upstream of the dam; and 0.9 to 9.8 fps, 1,500 ft upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. Generally the maximum velocities occurred near midchannel with the velocities of the current near the left bank being somewhat slower. The maximum velocities of the currents in the immediate forebay of the lock varied from less than 1.0 to 6.6 fps with the 20,000- and 142,000-cfs riverflows. The flow moved through the dam and was parallel with the lock from the dam to the downstream end of the guard wall. At the downstream end of the guard wall, some flow moved across the trail dike and into the lower lock approach. However, most of the flow moved around the end of the dike and across the lock approach and became parallel with the left bank about 1,000 ft downstream of the dike. A large counterclockwise eddy formed between the trail dike and the

left bank with a maximum upstream velocity of 2.8 fps with the 100,000-cfs riverflow. The maximum velocities of the currents in the navigation channel approaching the lock varied from 5.5 to 12.6 fps with the 20,000- and 142,000-cfs riverflows, respectively.

Navigation conditions. Navigation conditions were satisfactory for downbound tows approaching the lock with riverflows through 60,000 cfs. Downbound tows could drive close along the left bank from the upstream end of the model to a point two or three tow lengths upstream of the upstream end of the guard wall, start flanking to reduce speed, and approach the guard wall at a safe speed. As the tow moved into the lock forebay and the head of the tow approached the midpoint of the guard wall, there was a tendency for the head of the tow to be pulled into the guard wall. An upbound tow could move the head of the tow away from the guard wall and navigate upstream along the longitudinal dike without any major difficulty. As the riverflow increased to 80,000 cfs, navigation conditions became difficult to hazardous for downbound tows. The large eddy that formed along the left bank downstream of dike 142.8R adversely affected the movement of the tow as the flow increased. There was a tendency for the tow to be moved out of alignment with the guard wall as it entered the excavated channel, and it had difficulty aligning with the guard wall and entering the lock approach. A downbound tow was required to drive to a point about one tow length upstream of the guard wall and try to reduce speed by flanking as it entered the lock forebay. The tow could not reduce its speed to approach the guard wall at a safe speed. An upbound tow had difficulty moving the head of the tow away from the guard wall due to the high velocities of the currents. If the tow had sufficient power to rotate the head of the tow off the guard wall, it could navigate the reach without any major difficulty. However, some additional maneuvering was required near the upstream end of the excavated channel due to the effects of the eddy that formed along the right bank in the area.

Navigation conditions were satisfactory for tows entering and leaving the lower lock approach with all riverflows. However, a high-powered tow would be required to navigate the reach with the higher riverflows. Downbound tows could leave the lower lock approach, turn into the main channel, and navigate downstream without any major difficulty. Upbound tows could approach the lock, turn into the lock approach, and land on the guard wall without any major difficulty. However, with riverflows of 80,000 cfs and above, tows would encounter high-velocity currents and tows with normal or low power may have some difficulty navigating the reach.

Plan G-1

Description

Plan G-1 (Figure 14) was the same as Plan G except:

a. Dikes 142.6R and 142.4R were added along the right bank to provide a uniform 600-ft-wide channel approaching the excavated channel.

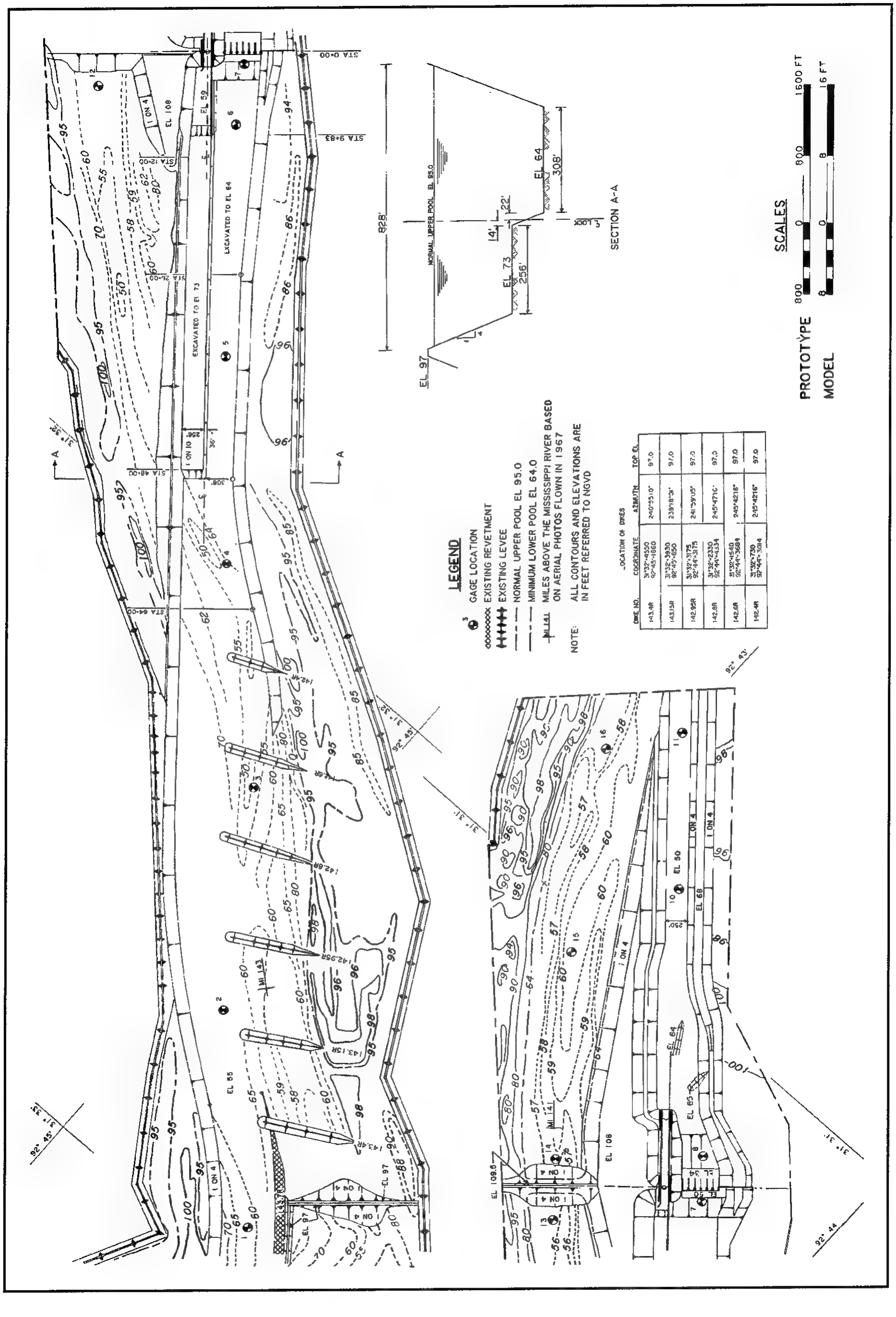


Figure 14. Plan G-1

b. The right bank was realigned from sta 26+00 to sta 64+00. The toe of the right bank slope was move landward about 110 ft at sta 48+90 to provide a 600-ft-wide channel at that point. The right bank did not change upstream of sta 64+00 or downstream of sta 26+00.

c. The upstream end of the el 73.0 excavation along the left bank was tied into the existing channel contours with a 1V on 10H slope. The top of the slope was perpendicular to the left bank and started at sta 48+00.

Results

Water-surface elevations. Water-surface elevations obtained with Plan G-1 are shown in Table 10. These data show that the slope in water-surface elevations through the reach was generally the same as with Plan G. The slope in water-surface elevations varied from less than 0.1 to 1.6 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The slope in water-surface elevation downstream of the dam varied from less than 0.8 to 1.8 ft per mile with the 20,000- and 100,000-cfs riverflows, respectively. The drop through the dam was 0.4 ft with the 142,000-cfs uncontrolled riverflow.

Table 10
Water-Surface Elevations, Plan G-1

	Water-Surface Elevations for Discharge in 1,000 cfs				
Gauge No.	20	60	80	100	142
1	95.0	94.8	90.3	92.0	96.9
2	95.0	94.7	90.1	91.7	96.3
3	95.0	94.5	89.4	90.9	95.4
4	95.0	94.4	89.3	90.8	95.3
5	95.0	94.2	88.5	89.7	94.1
6	95.0	94.2	88.2	89.4	93.8
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	93.0
Axis of Dam					
8	70.8	81.0	84.4	87.2	92.6
9	70.3	80.0	83.2	85.7	91.4
10	70.3	79.9	83.1	85.8	91.7
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.3	0.9	1.2	1.6
Gauges 8-11	0.8	1.3	1.6	1.8	1.2

[1] Controlled elevations.

Current directions and velocities. Current direction and velocities obtained with Plan G-1 are shown in Plates 37-41. These data show that the alignments and velocities of the currents upstream of the dam were generally the same as with Plan G except in the vicinity of sta 48+00 where the channel was enlarged. Enlarging the channel to 600 ft at sta 48+00 reduced the maximum velocities of the current through this reach 25 to 40 percent. The velocities of the currents were more uniform throughout the reach upstream of the dam. Adding dikes 142.6R and 142.4R along the right bank reduced the size of the eddy that formed in this area and kept the alignment of the currents parallel with the right bank through the reach. The maximum velocities of the currents upstream of the dam varied from 1.6 to 10.9 fps, 6,400 ft upstream of the dam; 1.4 to 10.3 fps, 4,800 ft upstream of the dam; and 1.0 to 9.3 fps, 1,500 ft upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The maximum velocities of the currents in the immediate forebay of the lock varied from less than 1.0 to 6.7 fps with the 20,000- and 142,000-cfs riverflows.

Navigation conditions. Navigation conditions were generally the same as with Plan G except in the area where the right bank was changed and the dikes were added along the right bank. With all riverflows evaluated, downbound tows could drive along the left descending bank from the upstream end of the model to a point two or three tow lengths upstream of the guard wall, start flanking to reduce speed, and enter the lock forebay aligned with the guard wall and lock chamber. However, with riverflows of 100,000 cfs and above, a downbound tow would have difficulty reducing speed and approaching the guard wall at a safe speed due to the high velocities of the currents. As the tow entered the lock forebay and reduced speed, there was a tendency for the currents to move the head of the tow into the guard wall with considerable force. An upbound tow had difficulty moving the head of the tow away from the guard wall due to the high velocities of the currents. If the tow had sufficient power to rotate the head of the tow away from the guard wall, it could navigate the reach without any major difficulty. Navigation conditions for tows entering and leaving the lower lock approach with this plan were the same as those with Plan G.

Plan G-2

Description

Plan G-2 (Figure 15) was the same as Plan G-1 except for replacing the system of spur dikes along the right bank upstream of the dam with a system of vane dikes. Using vane dikes in place of spur dikes, which are connected to the bank, would reduce the linear feet of dikes and the amount of stone required to construct the dikes. The number, length, angle, and location of the vane dikes were designed during preliminary experiments. The differences between Plans G-2 and G-1 are as follows:

a. The system of six spur dikes along the right descending bank upstream of the dam was replaced by a system of five vane dikes and a longitudinal

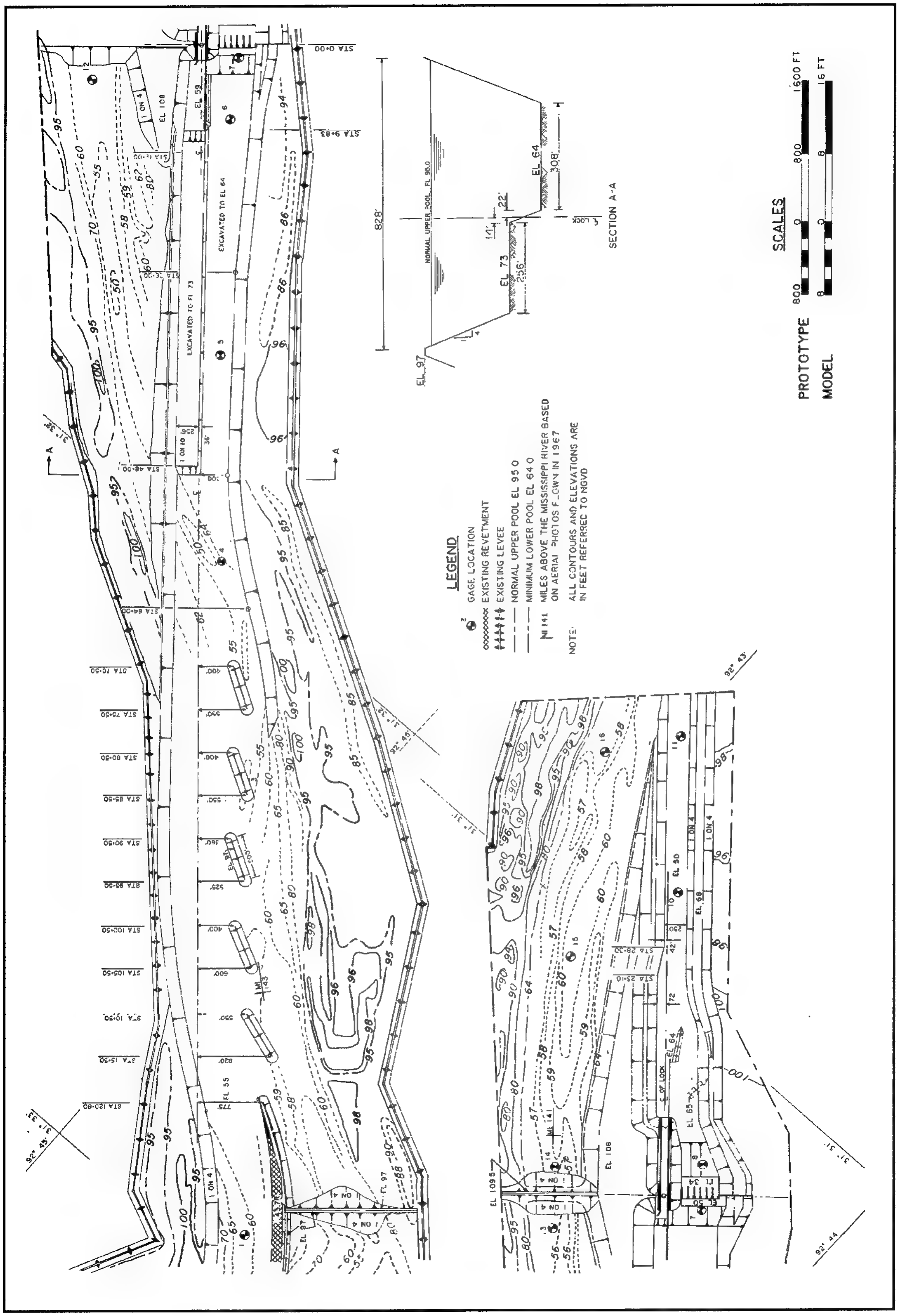


Figure 15. Plan G-2

dike. The vane dikes were 500 ft long with top el 97.0. There was a 500-ft opening between the dikes, and to minimize the amount of flow passing between the dikes, they were placed at an angle to the flow and the center line of the lock. The downstream ends of the vane dikes were positioned to provide a 600-ft-wide channel between the toe of the dike and the toe of the left bank.

b. A longitudinal dike with top el 97.0 extended downstream from the intersection of revetment 143.7R and the existing channel closure dike. The longitudinal dike followed the curvature of the left bank and provided a 600-ft-wide channel through the reach.

Results

Water-surface elevations. Water-surface elevations obtained with Plan G-2 are shown in Table 11. These data show a slight decrease in the slopes in water-surface elevations upstream of the dam with the 60,000-cfs and above riverflows compared with Plan G-1. The slopes in water-surface elevations downstream of the dam were generally the same as with Plan G-1. The slopes in water-surface elevations varied from less than 0.1 to 1.3 ft per mile upstream of the dam with the 20,000- and the 142,000-cfs riverflows, respectively. The slopes in water-surface elevation downstream of the dam varied from 0.8 to 1.8 ft per

Table 11
Water-Surface Elevations, Plan G-2

	Water-Surface Elevations for Discharge in 1,000 cfs				
Gauge No.	20	60	80	100	142
1	95.0	94.6	90.0	91.6	96.3
2	95.0	94.5	89.8	91.4	96.1
3	95.0	94.5	89.6	91.2	95.6
4	95.0	94.4	89.5	91.0	95.5
5	95.0	94.2	88.5	89.8	94.1
6	95.0	94.1	88.2	89.6	93.8
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	93.0
Axis of Dam					
8	70.8	80.9	84.4	87.2	92.6
9	70.3	79.9	83.2	85.6	91.4
10	70.3	79.9	83.1	85.7	91.7
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.2	0.8	1.0	1.3
Gauges 8-11	0.8	1.2	1.6	1.8	1.4

[1] Controlled elevations.

mile with the 20,000- and 100,000-cfs riverflows, respectively. The drop through the dam was 0.4 ft with the 142,000-cfs uncontrolled riverflow.

Current directions and velocities. Current direction and velocities obtained with Plan G-2 are shown in Plates 42-46. These data show that the currents were generally parallel to the left descending bank from the upstream end of the model to the dam. The flow separated from the left bank opposite the new longitudinal dike, and a counterclockwise eddy formed along the left bank with all riverflows through 100,000 cfs. There was a significant decrease in the velocities of the currents from the upstream end of the model to about sta 64+00. Compared with Plan G-1, the decrease in the velocities of the currents at sta 48+00 varied from 0.6 to 4.1 fps with the 20,000- and 142,000-cfs riverflows, respectively. The maximum velocities of the currents upstream of the dam varied from 1.0 to 6.8 fps, 6,400 ft upstream of the dam; 1.4 to 10.3 fps, 4,800 ft upstream of the dam; and 0.9 to 9.8 fps, 1,500 ft upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The maximum velocities of the currents in the immediate forebay of the lock varied from less than 1.0 to 7.0 fps with the 20,000- and 142,000-cfs riverflows, respectively.

Navigation conditions. Navigation conditions were satisfactory for downbound tows approaching the lock with all riverflows. Tows navigating upstream of the dam would encounter lower velocity currents through the area of the vane dike field than they encountered with the spur dikes. However, in the reach from the dam to sta 48+00, the velocities of the currents were generally the same as with the spur dikes. Downbound tows could enter the model reach near mid-channel, drive along the left descending bank to a point two or three tow lengths upstream of the guard wall, start flanking to reduce speed, and approach the guard wall with good alignment and without any major difficulty. However, with riverflows of 100,000 cfs and above, a downbound tow would have difficulty reducing speed and entering the lock forebay at a safe speed. As the head of the tow reached the midpoint of the guard wall, there was a tendency for the head of the tow to be pulled into the guard wall with considerable force. This movement was difficult to control. With the 100,000- and 142,000-cfs riverflows, upbound tows experienced some difficulty moving the head of the tow away from the guard wall due to the high velocities of the currents. If the tow had sufficient power to move the head of the tow away from the guard wall and move upstream against the currents, it could navigate the reach without any major difficulty. Navigation conditions were the same as those with Plans G and G-1 for tows entering and leaving the lower lock approach.

Plan G-3

Description

Plan G-3 was developed in the movable-bed model to reduce maintenance dredging upstream of the dam and in the upper lock approach. Plan G-3 (Figure 16) was the same as Plan G-2 except for the following:

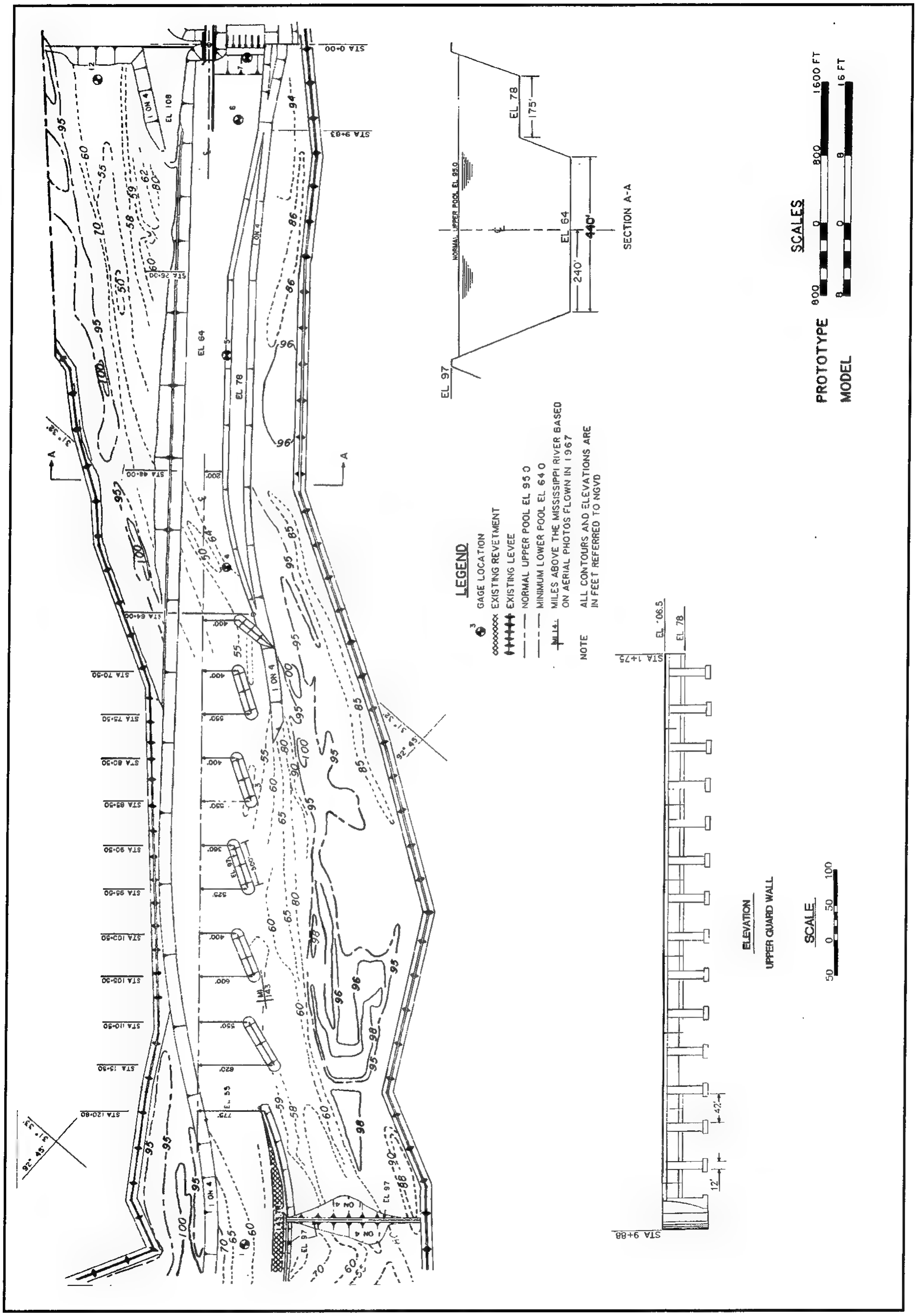


Figure 16. Plan G-3

a. The 256-ft-wide berm along the left descending bank upstream of the lock forebay was removed.

b. The forebay of the lock was raised from el 59.0 to el 64.0. The top of the ports in the upper guard wall were at el 78.0 providing fourteen 42-ft-wide ports and one 21-ft-wide port.

c. A 175-ft-wide berm with top el 78.0 (Section A-A, Figure 16) was placed along the right bank of the lock channel between sta 26+00 and 48+00. Downstream of sta 26+00, the berm was angled toward the right bank and tied into the existing bank at sta 9+83. Upstream of sta 48+00, the berm curved toward the right bank and tied into the existing bank at 64+00.

d. A spur dike was added along the right bank immediately downstream of the vane dikes and upstream of the lock channel at sta 84+50 to maintain a 600-ft-wide channel. The spur dike was angled downstream and had a top elevation of 97.0.

Results

Water-surface elevations. Water-surface elevations obtained with Plan G-3 are shown in Table 12. These data show that the slopes in water-surface elevations were generally the same as Plans G, G-1, and G-2. The slopes in water-surface elevations varied from less than 0.1 to 1.3 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The slopes in water-surface elevation downstream of the dam varied from less than 0.8 to 1.8 ft per mile with the 20,000- and 100,000-cfs riverflows, respectively. The drop through the dam was 0.4 ft with the 142,000-cfs uncontrolled riverflow.

Current directions and velocities. Current direction and velocities obtained with Plan G-3 are shown in Plates 47-51. These data show that the current pattern was generally the same as with Plan G-2. The currents were generally parallel with the left descending bank from the upstream end of the model to the lock. With the 20,000-cfs riverflow, a large counterclockwise eddy formed in the forebay of the lock, and a large clockwise eddy formed along the right bank in the vicinity of the berm. The maximum velocities of the currents upstream of the dam varied from 1.1 to 6.8 fps, 6,400 ft upstream of the dam; 1.4 to 10.7 fps, 4,800 ft upstream of the dam; and 0.9 to 9.8 fps, 1,500 ft upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The maximum velocities of the currents in the immediate forebay of the lock varied from less than 1.0 to 7.1 fps with the 20,000- and 142,000-cfs riverflows. With the 100,000- and 142,000-cfs riverflows, the angle and velocities of the currents in the lock forebay near the downstream end of the guard wall appeared to increase compared with Plan G-2.

Navigation conditions. Navigation conditions were generally the same as with Plan G-2. Downbound tows could drive along the left bank to a point two or three tow lengths upstream of the guard wall, start flanking to reduce speed,

Table 12
Water-Surface Elevations, Plan G-3

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs				
	20	60	80	100	142
1	95.0	94.6	90.0	91.6	96.3
2	95.0	94.5	89.8	91.4	96.1
3	95.0	94.5	89.6	91.2	95.6
4	95.0	94.4	89.5	91.0	95.5
5	95.0	94.2	88.5	89.8	94.1
6	95.0	94.1	88.2	89.6	93.8
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	93.0
Axis of Dam					
8	70.8	80.9	84.4	87.2	92.6
9	70.3	79.9	83.2	85.6	91.4
10	70.3	79.9	83.1	85.7	91.7
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.2	0.8	1.0	1.3
Gauges 8-11	0.8	1.2	1.6	1.8	1.7

[1] Controlled elevations.

and enter the lock forebay with good alignment for approaching the guard wall. However, with riverflows of 100,000 cfs and above, a downbound tow would have some difficulty reducing speed and approaching the guard wall at a safe speed due to the high velocities of the currents. As the head of the tow reached the midpoint of the guard wall, it was pulled into the guard wall with considerable force. A tow could land the head of the tow near the upstream end of the guard wall without any difficulty; however, if the tow lost control, it could be rotated around the upstream end of the guard wall. A tow moving deep into the forebay along the left bank could have the head of the tow pulled into the guard wall at a steep angle and considerable force. With the 100,000- and 142,000-cfs riverflows, an upbound tow had some difficulty moving the head of the tow away from the guard wall due to the high velocities of the currents. If the tow had sufficient power to move the head of the tow away from the guard wall before it left the protection of the wall and move upstream against the high velocities of the currents, it could navigate the reach without any major difficulty. An upbound tow attempting to drive straight upstream along the guard wall could be rotated around the upstream end of the guard wall or pinned on the wall. Navigation conditions for tows entering and leaving the lower lock approach were the same as with Plans G, G-1, and G-2 with all riverflows.

Plan G-4

Description

Plan G-4 (Figure 17) was the same as Plan G-3 except that an entrance for a maintenance facility was cut through the left bank longitudinal dike extending upstream from the lock esplanade. The design size vessel for the maintenance facility entrance was two 50-ft-wide by 200-ft-long barges tied abreast of each other with a 100-ft-long pusher for a total size of 100 ft wide by 300 ft long. The location and the width of the entrance were selected during preliminary experiments with input from operation personnel from the Vicksburg District. The location and width selected for complete documentation was a 664-ft-wide entrance with bottom el 73.0 located between sta 43+00 and 49+64.

Results

Water-surface elevations. Water-surface elevations obtained with Plan G-4 are shown in Table 13. These data show that the slopes in water-surface elevations upstream and downstream of the dam were the same as with Plans G, G-1, G-2, and G-3. The slopes in water-surface elevations varied from less than 0.1 to 1.2 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows,

Table 13
Water-Surface Elevations, Plan G-4

	Water-Surface Elevations for Discharge in 1,000 cfs				
Gauge No.	**20**	**60**	**80**	**100**	**142**
1	95.1	94.6	90.0	91.7	96.3
2	95.1	94.5	89.9	91.5	96.1
3	95.1	94.4	89.7	91.3	95.6
4	95.1	94.3	89.5	90.9	95.5
5	95.1	94.2	88.5	89.7	94.1
6	95.0	94.1	88.2	89.4	93.8
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	93.0
Axis of Dam					
8	70.8	80.9	84.4	87.2	92.6
9	70.3	79.9	83.2	85.7	91.7
10	70.3	79.9	83.1	85.7	91.6
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.2	0.8	1.1	1.2
Gauges 8-11	0.8	1.2	1.6	2.0	1.7

[1] Controlled elevations.

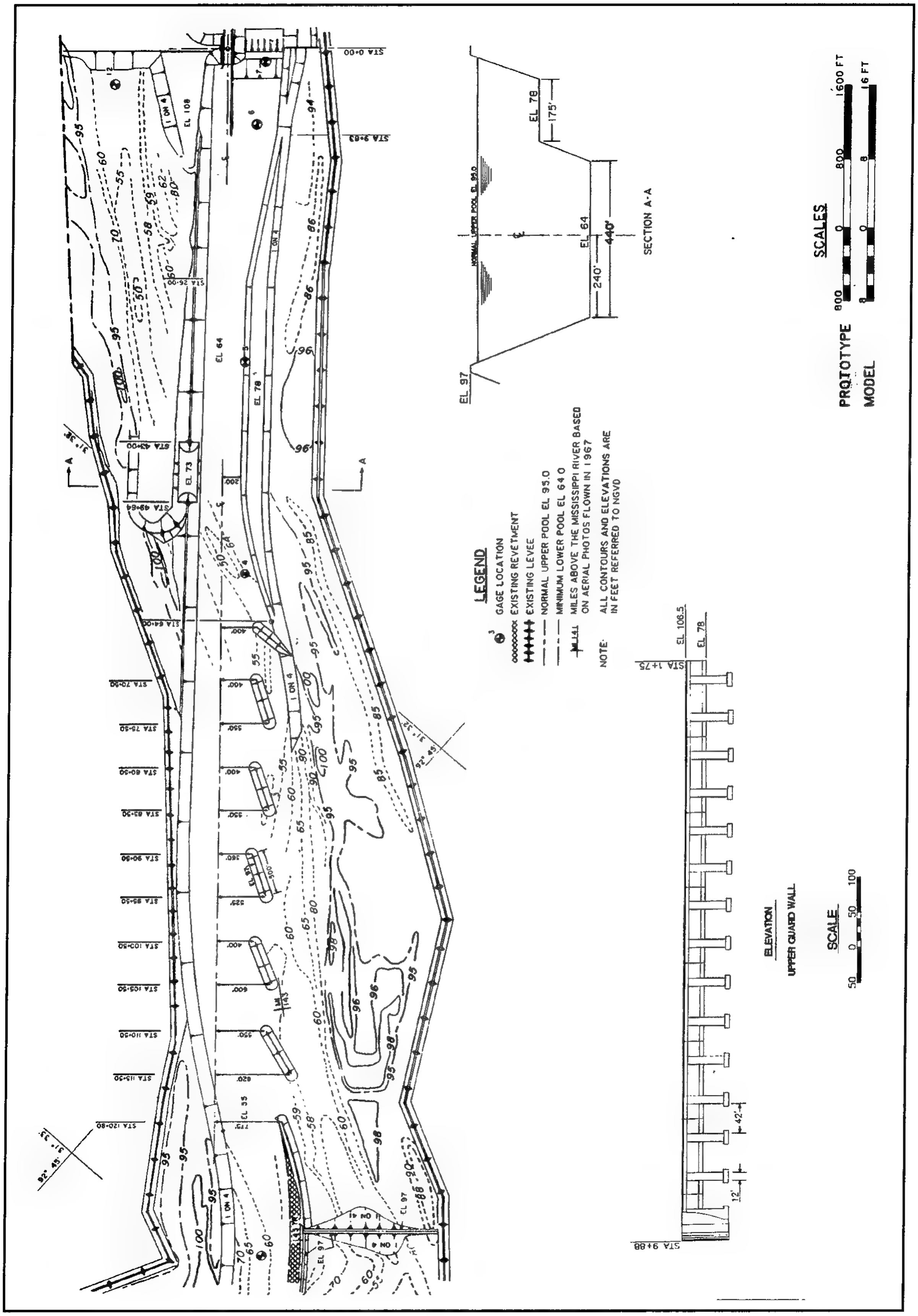


Figure 17. Plan G-4

respectively. The slopes in water-surface elevation downstream of the dam varied from less than 0.8 to 2.0 ft per mile with the 20,000- and 100,000-cfs riverflows, respectively. The drop through the dam was 0.4 ft with the 142,000-cfs uncontrolled riverflow.

Current directions and velocities. Current direction and velocities obtained with Plan G-4 are shown in Plates 52-56. These data show that the current pattern in the main river channel was generally the same as with Plan G-3. The currents were parallel with the left bank past the entrance to the maintenance facility with a counterclockwise eddy forming in the entrance of the maintenance facility. The eddy extended into the maintenance facility but had little or no effect on the currents in the main river channel.

Navigation conditions. Navigation experiments were conducted with both the project design size tow entering and leaving the upper lock approach and the maintenance vessel entering and leaving the maintenance facility. The maintenance entrance did not adversely affect tows entering and leaving the upper lock approach. A downbound tow could drive along the left descending bank, move past the harbor entrance, start reducing speed two or three tow lengths upstream of the guard wall, and enter the lock forebay with good alignment. Upbound tows could move past the harbor entrance without any difficulty. A 100-ft-wide by 300-ft-long work boat and barge train were used to evaluate conditions for work boats entering and leaving the maintenance facility. A work boat entering the maintenance facility from the main river channel was required to approach the entrance from the downstream side, move up even with the entrance, rotate the head of the tow into the entrance, and while maintaining control, drive into the maintenance facility. With the higher riverflows, this maneuver became very difficult and could be hazardous. A work boat with barge leaving the facility was required to approach the facility from the downstream side, move the boat into the entrance almost parallel with the longitudinal dike, and allow the head of the barge to enter the main riverflow at a slight angle. If the boat pushed the head of the barge into the main riverflow at too great an angle, the boat would be unable to control the barge due to the high velocities of the currents, and the boat and barge could be swept downstream toward the lock guard wall. As the riverflow increased, this maneuver became more difficult and, in some cases, could become hazardous.

Series H Plans

A series of experiments were conducted to develop a 350-ft-wide downstream outlet channel configuration that would not encroach within 100 ft of the existing transmission tower located along the right descending bank and would provide acceptable navigation conditions for tows entering and leaving the lower lock approach. The channel was evaluated with and without an overflow berm along the right descending bank.

Plan H

Description

Plan H was evaluated with and without a trail dike near the downstream end of the guard wall. Plan H with dike (Figure 18) was the same as Plans G and G-4 except for the following:

a. The downstream outlet channel was modified to provide a 350-ft-wide channel at el 50.0 or 286 ft at bottom el 42.0.

b. The bottom elevation of the outlet channel was lowered from el 50 to el 42 from sta 19+80 downstream to its confluence with the existing river channel.

c. The 50-ft berm with top el 76.0 along the left descending bank was eliminated by moving the toe of the slope landward.

d. The right bank was realigned from the dam downstream to its intersection with the existing river channel. The toe of the right bank was straight from the southwest end of the dam to its convergence with the 350-ft-wide outlet channel at sta 25+00.

e. The upstream angled spur dike along the right bank immediately downstream of the dam was removed.

f. A 225-ft-long trail dike with top el 66.0 was placed near the downstream end of the lower guard wall. The upstream end of the dike was located at the downstream end of the guard wall and angled 15 deg riverward from parallel to the center line of lock.

Results

Water-surface elevations. Water-surface elevations measured with Plan H are shown in Table 14. These data show that the slopes in water-surface elevations upstream of the dam were generally the same as with Plan G-4, and the slopes in water-surface elevations downstream of the dam decreased somewhat. The slopes in water-surface elevations varied from less than 0.1 to 1.4 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The slopes in water-surface elevation downstream of the dam varied from 0.1 to 1.0 ft per mile with the 20,000- and 100,000-cfs riverflows, respectively. The drop through the dam was 0.1 ft with the 142,000-cfs uncontrolled riverflow.

Current directions and velocities. Current direction and velocity data obtained with Plan H without a trail dike are shown in Plates 57-61. With all riverflows evaluated, a large counterclockwise eddy formed in the lower lock approach that extended downstream approximately 1,500 ft from the

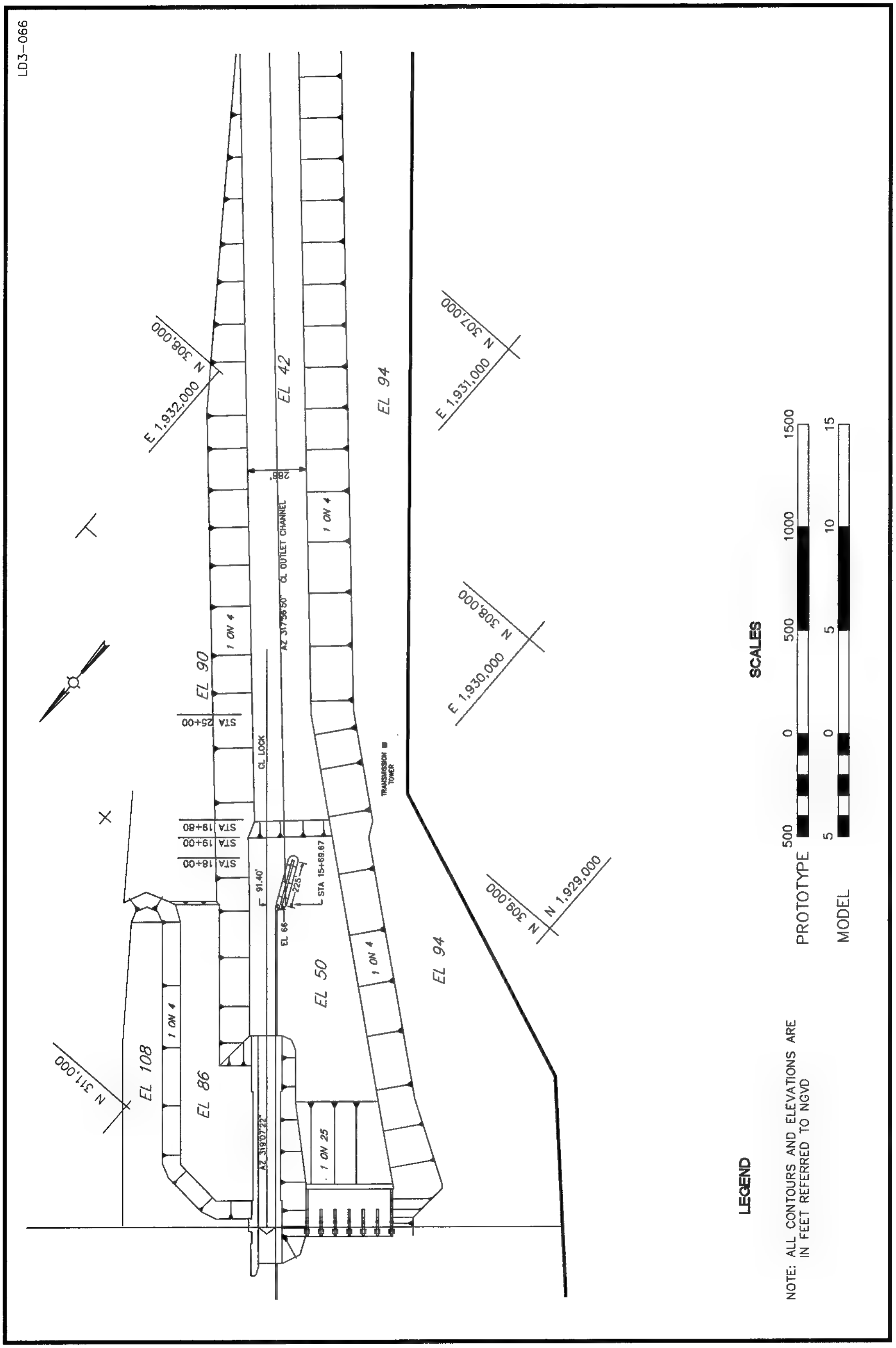


Figure 18. Plan H with dike

Table 14
Water-Surface Elevations, Plan H

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs				
	20	60	80	100	142
1	95.1	94.6	90.0	91.7	95.9
2	95.1	94.5	89.9	91.5	95.7
3	95.1	94.4	89.7	91.3	95.4
4	95.1	94.3	89.5	90.9	94.8
5	95.1	94.2	88.5	89.7	93.9
6	95.0	94.1	88.2	89.4	93.0
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	92.4
Axis of Dam					
8	70.2	80.4	83.8	86.5	92.3
9	70.1	79.9	83.2	85.8	91.7
10	70.1	79.9	83.1	85.7	91.6
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.2	0.8	1.1	1.4
Gauges 8-11	0.1	0.7	0.8	1.0	0.9

[1] Controlled elevations.

downstream end of the guard wall. The upstream currents in the approach to the lock varied from less than 0.5 fps with a riverflow of 20,000 cfs to approximately 4.3 fps with the 100,000-cfs riverflow. The maximum velocity of the currents in the navigation approach to the lock varied from about 3.1 to 10.2 fps with the 20,000- and 142,000-cfs riverflows, respectively. Current direction and velocity data shown in Plates 62-66 indicate that adding a trail dike increased the intensity of the eddy in the lower lock approach with all riverflows evaluated. The maximum upstream currents in the approach to the lock varied from about 1.0 to 5.0 fps with the 20,000- and 142,000-cfs riverflows, respectively.

Navigation conditions. Navigation conditions were unacceptable with Plan H either with or without a trail dike for tows entering and leaving the lock due to the size and intensity of the eddy in the lower lock approach, especially with high riverflows. There was a tendency for the head of an upbound tow approaching the lock to be moved riverward into the downstream end of the guard wall with considerable force by the upstream currents in the eddy. With the higher riverflows, there was a tendency for downbound tows leaving the lock to be moved into the left bank about 1,500 ft downstream of the lock. Adding a trail dike near the downstream end of the guard wall increased the tendency for

an upbound tow to be moved into the guard wall with considerable force or rotated in the approach.

Plan H-1

Description

Plan H-1 (Figure 19) was the same as Plan H with a trail dike except a 100-ft-wide overflow berm at el 69.0 was placed along the right bank beginning at sta 23+74 and extending downstream to its intersection with the existing river channel.

Results

Water-surface elevations. Water-surface elevations measured with Plan H-1 are shown in Table 15. These data show that the slopes in water-surface elevations are generally the same as with Plan H.

Current directions and velocities. Current direction and velocity data taken with Plan H-1 and shown in Plates 67-71 indicate no significant change in the currents in the navigation channel. An eddy formed along the right bank immediately downstream of sta 25+00 and extended downstream about 1,200 ft indicating that the berm would carry little or no flow.

Navigation conditions. Navigation conditions were generally the same as with Plan H with a trail dike for all riverflows evaluated.

Plan H-2

Description

Plan H-2 (Figure 20) was the same as Plan H without dike except the right bank was realigned from the dam to sta 25+00. The toe of the right bank was parallel to and 380 ft from the center line of the lock from sta 8+50 to sta 19+00 and then converged with the 350-ft outlet channel at sta 25+00. This plan moved the right bank of the outlet channel closer to the transmission tower.

Results

Current directions and velocities. Current direction and velocity data shown in Plates 72-76 indicate that the size of the eddy in the lower approach to the lock was reduced slightly compared with Plan H; however, the velocity of the upstream current increased slightly. A low-velocity eddy formed along the

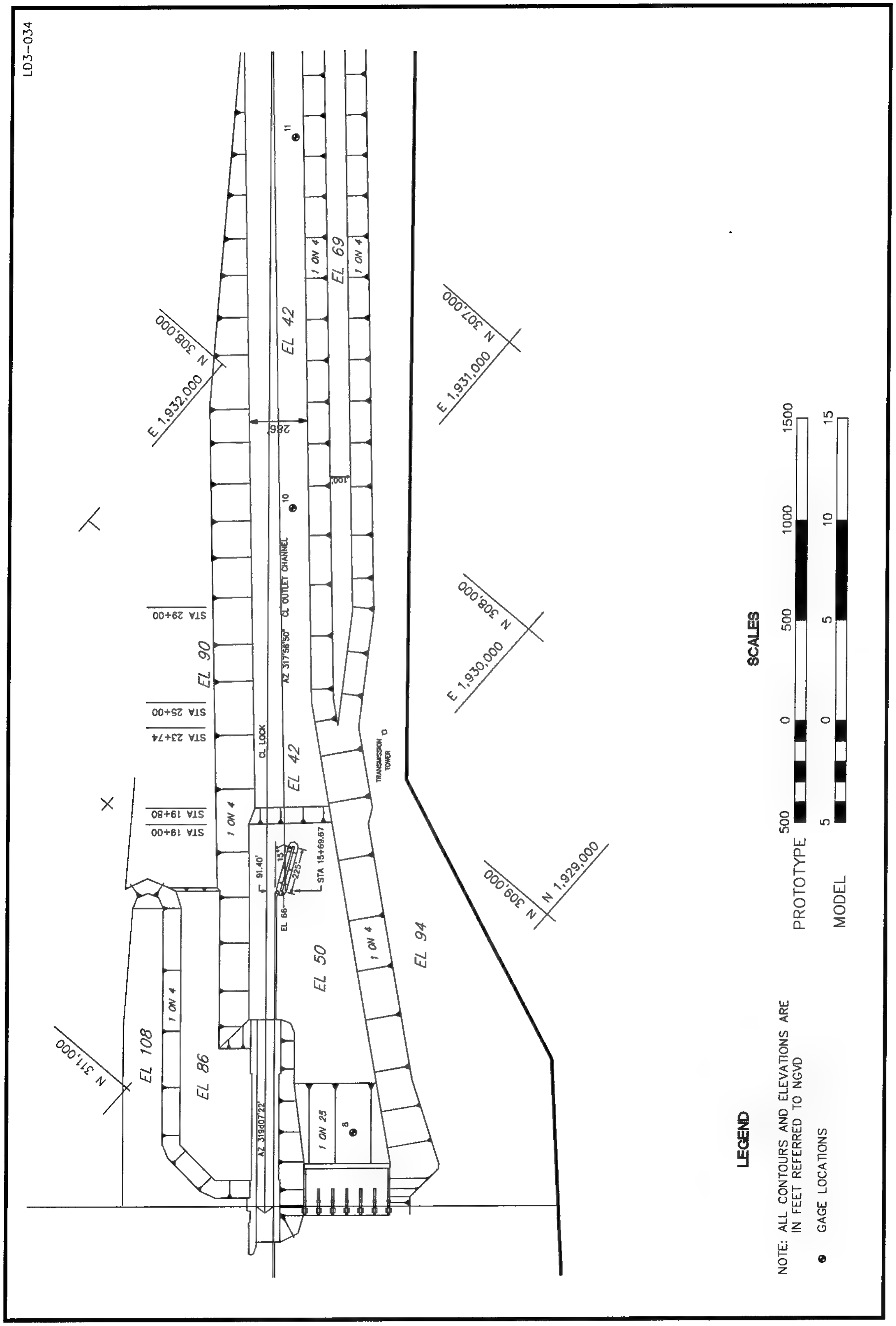


Figure 19. Plan H-1

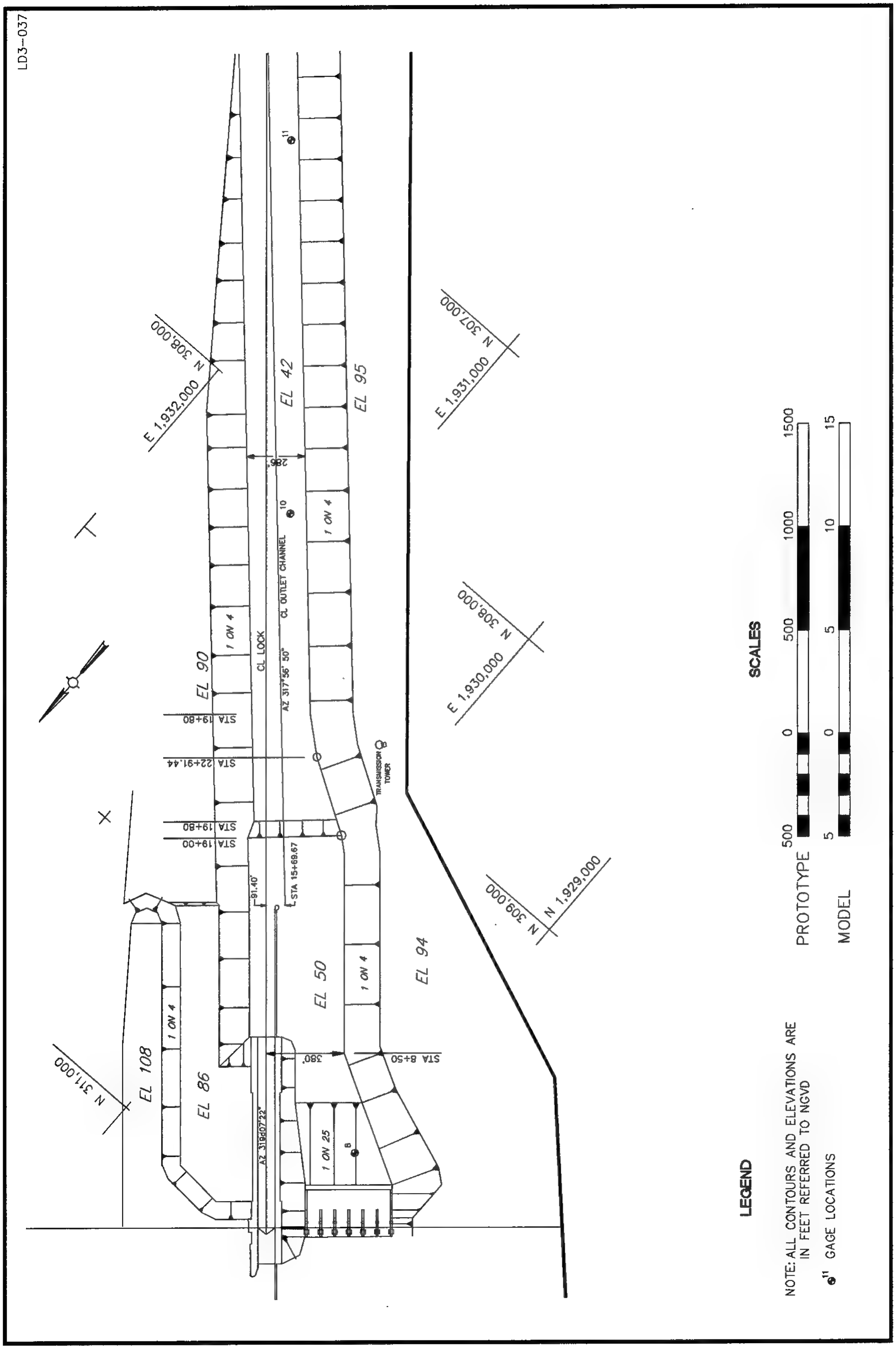


Figure 20. Plan H-2

Table 15
Water-Surface Elevations, Plan H-1

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs				
	20	60	80	100	142
1	95.1	94.6	90.0	91.7	95.9
2	95.1	94.5	89.9	91.5	95.7
3	95.1	94.4	89.7	91.3	95.4
4	95.1	94.3	89.5	90.9	94.8
5	95.1	94.2	88.5	89.7	93.9
6	95.0	94.1	88.2	89.4	93.0
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	92.4
Axis of Dam					
8	70.2	80.4	83.7	86.5	92.3
9	70.1	79.9	83.2	85.8	91.7
10	70.1	79.8	83.1	85.7	91.6
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.2	0.8	1.1	1.5
Gauges 8-11	0.1	0.7	0.8	1.0	0.9

[1] Controlled elevations.

left bank downstream of sta 25+00. The alignment and velocity of the currents in the navigation channel were generally the same as with Plan H.

Navigation conditions. Navigation conditions were generally the same as with Plan H. There was a tendency for upbound tows to be moved into the guard wall with considerable force with the higher riverflows.

Plan H-3

Description

Plan H-3 (Figure 21) was the same as Plan H-2 with the following exceptions:

a. A 100-ft-wide berm with top el 69.0 was added along the right bank beginning at the dam and extending downstream to its intersection with the existing river channel.

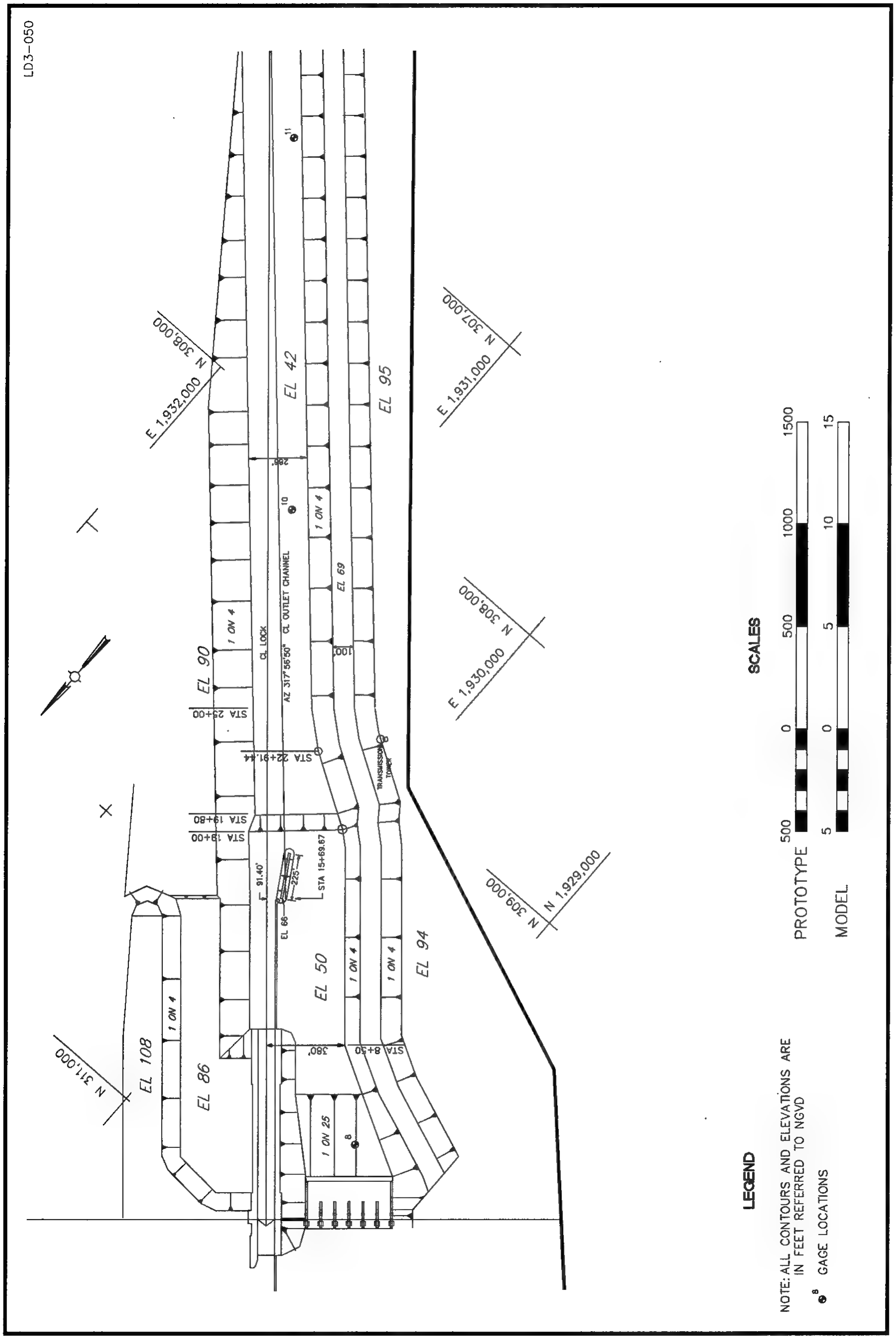


Figure 21. Plan H-3

b. A 225-ft-long trail dike with top el 66.0 was placed near the downstream end of the downstream guard wall. The upstream end of the dike was located at the downstream end of the guard wall and angled 15 deg riverward from parallel to the center line of the lock.

Results

Current directions and velocities. Current direction and velocity data shown in Plates 77-79 indicate that the trail dike increased the velocities of the upstream currents in the lower approach to the lock and the velocity of the currents in the navigation channel compared with Plan H-2. The currents were moving across the lock approach with maximum velocities ranging from about 2.2 to 5.9 fps with the 20,000- and 142,000-cfs riverflows, respectively. A large eddy formed along the right bank beginning at about sta 25+00 and extending downstream approximately 1,500 ft with the higher riverflows indicating that the berm was not carrying flow.

Navigation conditions. Navigation conditions were unacceptable for tows entering and leaving the lower lock approach with this plan. At higher riverflows, an upbound tow approaching the lock could be moved upstream with considerable speed and rotated counterclockwise by the eddy with a high probability of being moved into the downstream end of the guard wall with considerable force. There was a tendency for a downbound tow to be moved into the left bank about 1,600 ft downstream of the lock by currents moving across the navigation channel.

Plan H-4

Description

Plan H-4 (Figure 22) was the same as Plan H-3 except the right bank was realigned from the dam to sta 25+00. The right bank was extended upstream on a 4,605.82-ft radius from sta 25+00 to sta 9+36.91 and then tied into the dam with straight bank lines. This plan placed the right top bank about 50 ft riverward of the transmission tower. The 225-ft-long trail dike near the downstream end of the guard wall was parallel with the center line of the lock.

Results

Current directions and velocities. Current direction and velocity data shown in Plates 80-82 indicate that the eddy in the vicinity of the lower lock approach was reduced in size and intensity and was moved downstream away from the downstream end of the guard wall compared with the previous plans. The maximum velocities of the upstream currents in the eddy varied from about 1.2 to 2.9 fps with the 20,000- and 142,000-cfs riverflows, respectively. The

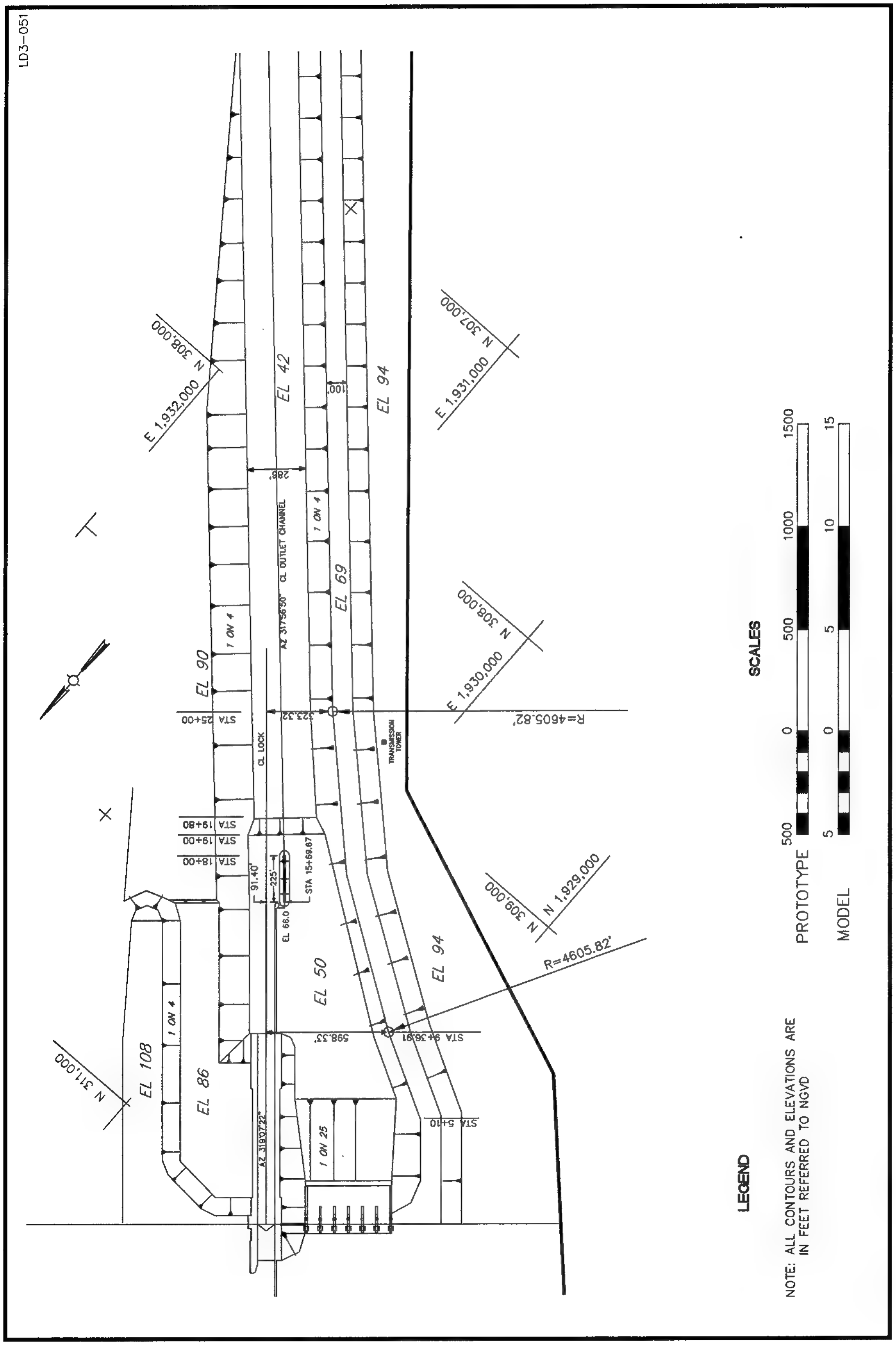


Figure 22. Plan H-4

currents were generally parallel to the left bank line with the 20,000- and 60,000-cfs riverflows. As the riverflow increased to 142,000 cfs, the currents moved toward the right bank about 1,500 ft downstream of the lock. A large eddy formed along the right bank beginning at about sta 15+00 and extending downstream from 1,200 to 1,600 ft with the riverflows evaluated. The maximum velocity of the currents in the navigation channel varied from about 4.5 to 10.4 fps with the 20,000- and 142,000-cfs riverflows, respectively.

Navigation conditions. Navigation conditions were satisfactory for tows entering and leaving the lower lock approach with all riverflows evaluated. Upbound tows could approach the guard wall and align with the lock chamber with a minimum of maneuvering; however, the tow would encounter high-velocity currents through the reach. Downbound tows could leave the lower lock approach and move to midchannel without any major difficulty.

Plan H-5

Description

Plan H-5 (Figure 23 and Photo 1) was the same as Plan H-4 except the 100-ft-wide berm along the right bank was removed downstream of sta 23+50 with a transition between sta 20+00 and sta 23+50. This placed the top of the right bank slope approximately 110 ft riverward of the transmission tower. The Vicksburg District recognized the possibility of Lock and Dam 3 being placed in service while John H. Overton Lock and Dam was maintaining an interim pool 4.0 ft lower than normal. Therefore, they requested that all future lower pool experiments include a 4.0-ft drawdown condition.

Results

Water-surface elevations. Water-surface elevations measured with Plan H-5 are shown in Table 16. These data show that the slopes in water-surface elevations are generally the same as with Plan H and H-1. The slopes in water-surface elevations varied from less than 0.1 to 1.4 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The slopes in water-surface elevation downstream of the dam varied from 0.1 to 0.9 ft per mile with the 20,000- and 142,000-cfs riverflow, respectively. The drop through the dam was 0.1 ft with the 142,000-cfs uncontrolled riverflow.

Current directions and velocities. Current direction and velocity data shown in Plates 83-87 indicate a slight change in the eddy in the lower lock approach and a slight increase in the currents moving across the approach compared with Plan H-4. However, the velocity of the currents was generally the same as with Plan H-4. The eddy along the right bank was reduced considerably in size. Current direction and velocity data taken with the water-surface elevation lowered about 4.0 ft in the vicinity of the lower guard wall are shown in Plates 88-90. Data indicate that the current patterns would generally be the same

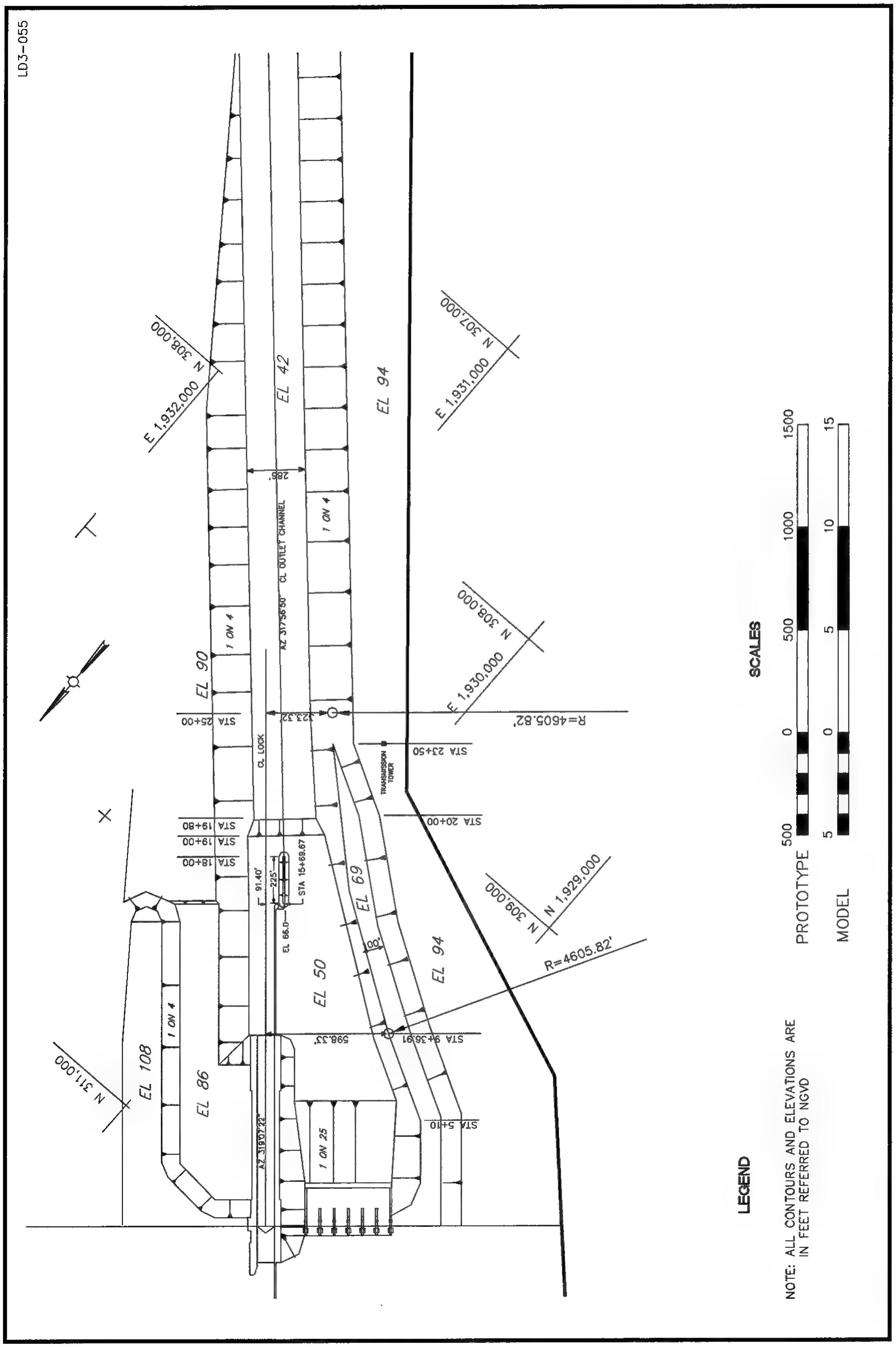


Figure 23. Plan H-5

Table 16
Water-Surface Elevations, Plan H-5

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs				
	20	60	80	100	142
1	95.1	94.6	90.0	91.7	96.0
2	95.1	94.5	89.9	91.5	95.8
3	95.1	94.4	89.7	91.3	95.5
4	95.1	94.3	89.5	90.9	95.5
5	95.1	94.2	88.5	89.7	93.9
6	95.0	94.1	88.2	89.4	93.2
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	92.4
Axis of Dam					
8	70.2	80.3	83.7	86.4	92.3
9	70.1	79.9	83.1	85.8	91.7
10	70.1	79.8	83.1	85.7	91.6
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.2	0.8	1.1	1.4
Gauges 8-11	0.1	0.6	0.8	0.9	0.9

[1] Controlled elevations.

as with the normal tailwater; however, there would be a significant increase in the velocity of the currents. The maximum velocity of the currents in the navigation channel varied from about 5.9 to 11.3 fps with the 20,000- and 142,000-cfs riverflow, respectively, compared with 4.3 to 10.1 with the normal tailwater.

Navigation conditions. Navigation conditions were satisfactory for tows entering and leaving the lower lock approach with all riverflows evaluated (Photos 2-7). Downbound tows could exit the lower lock approach and navigate the reach without any major difficulty (Photos 2-4). Upbound tows could navigate the reach, enter the lock approach, and land on the guard wall with a minimum of maneuvering (Photos 5-7). However, with the 142,000-cfs riverflow, an upbound tow would experience a slight increase in maneuvering as it approached the lock compared with Plan H-4. Tows would encounter very high velocities through the reach especially with the higher riverflows, but the alignment of the currents allowed the tows to enter and leave the lock approach with a minimum of maneuvering.

Plan H-6

Description

Plan H-6 (Figure 24) was the same as Plan H-5 except a 100-ft-wide berm was added along the right bank downstream of sta 31+00 at el 69.0. The berm began at sta 24+00 and made a transition into the 100-ft-wide berm at sta 31+00.

Results

Current directions and velocities. With all riverflows evaluated before the tailwater was lowered (Plates 91-93), a clockwise eddy formed on top of the berm beginning near sta 24+00 and extending downstream about 2,400 ft, showing that the berm would not carry a significant amount of flow. When the tailwater was lowered with the various riverflows (Plates 94-96), the increase in the average velocity of the currents in the navigation channel varied from 1.0 to 2.0 fps. However, there was no significant change in the current patterns.

Navigation conditions. There was no significant difference in navigation conditions for tows entering and leaving the lower lock approach compared with Plan H-5.

Plan I

Description

The Vicksburg District made the decision to develop a plan that would not require the removal of revetment 143.0L or require a setback of the levee in that area. Plan I was the channel realignment selected to meet those criteria. The alignment of the navigation channel near the upstream end of the model was similar to Plan D, and the channel approaching the lock was the same as Plans G-3 and G-4. The principal features of the plan were as follows (Figure 25 and Photo 8):

a. The navigation channel in the vicinity of revetment 143.0L was the same as Plan D.

b. The channel approaching the lock and dam was the same as Plans G-3 and G-4 from the dam upstream to sta 50+95. From sta 50+95 to the downstream end of revetment 143.0L, the dike was curved to tie into the downstream end of the revetment. The top of the dike was at el 97.0 and tied into the existing ground at revetment 143.0L.

c. The entrance to the maintenance facility was the same as Plan G-4.

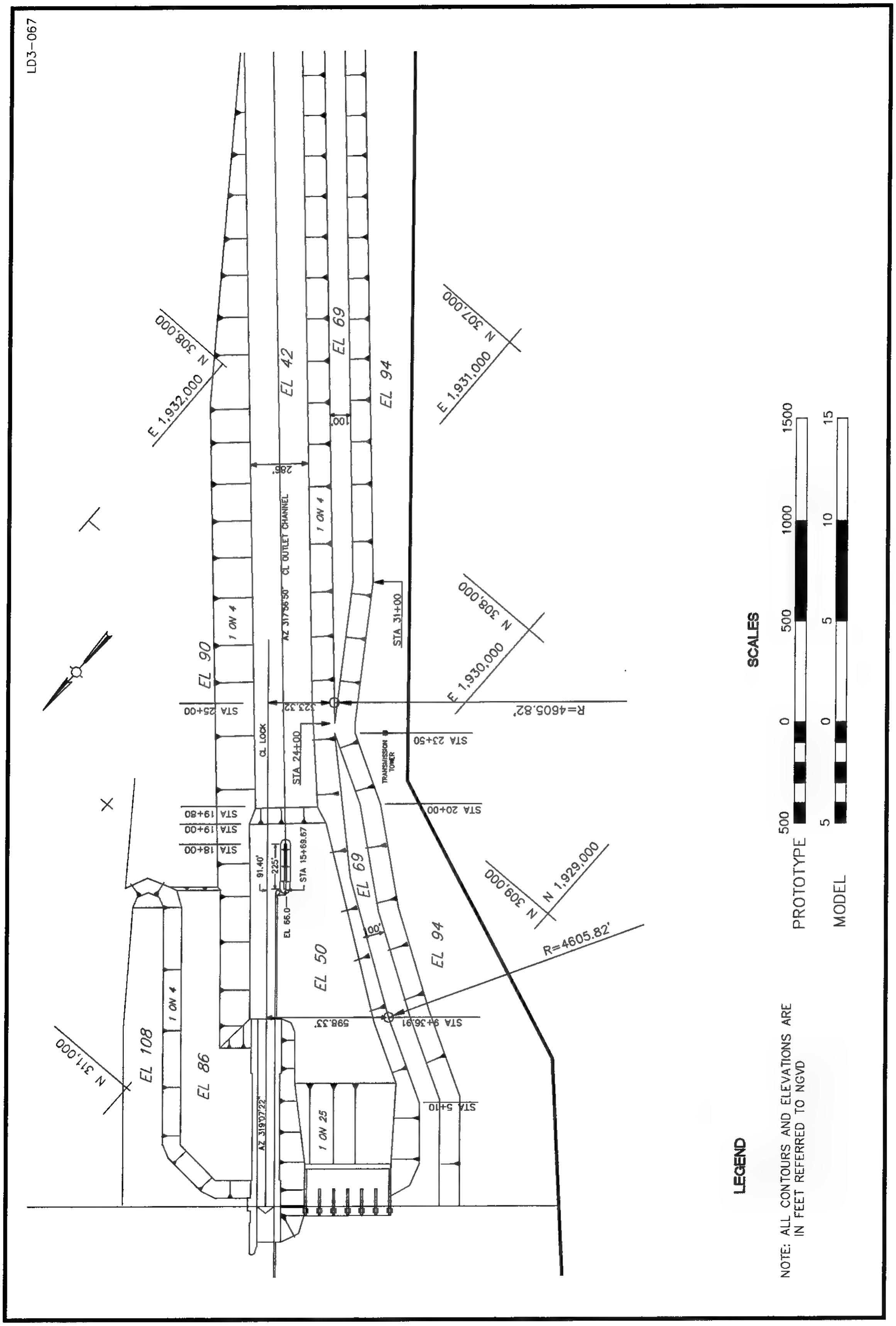
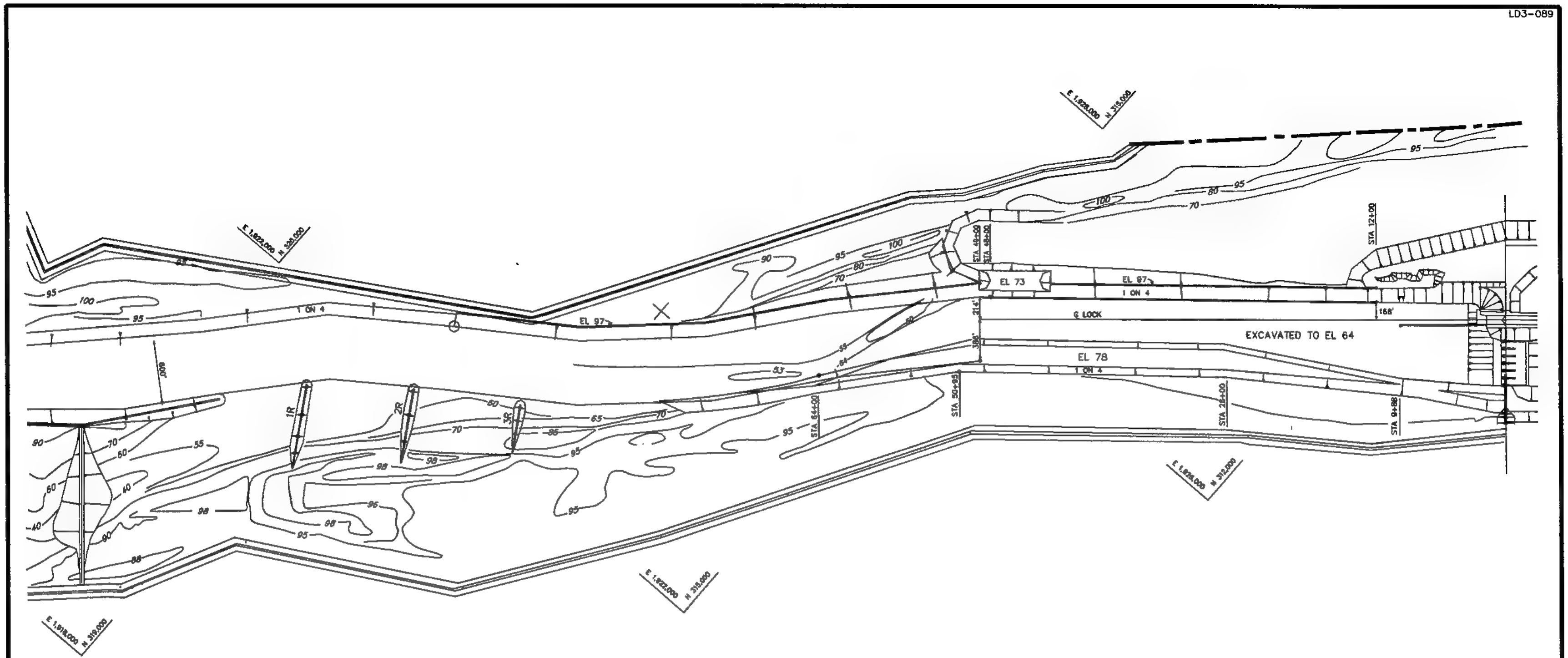


Figure 24. Plan H-6



NOTE: ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

DIKE LOCATIONS

DIKE NO.	COORDINATE	AZIMUTH	TOP EL
1R	E 1,921,297.22 N 319,071.68	239D07'22"	EL 97.0
2R	E 1,921,922.30 N 318,290.25	239D07'22"	EL 97.0
3R	E 1,922,460.91 N 317,434.17	239D07'22"	EL 97.0

SCALES

PROTOTYPE	500	0	500	1000	1500	2000
MODEL	5	0	5	10	15	20

Figure 25. Plan I

d. The right bank from about sta 79+00 to the dam was the same as Plans G-3 and G-4.

e. Three spur dikes were placed along the right descending bank to control the channel width. The river end of the dikes was placed to provide a 600-ft-wide channel between the end of the dikes and the left bank.

f. A longitudinal dike with top el 97.0 extended downstream from the intersection of revetment 143.7R and the existing channel closure dike. The longitudinal dike followed the curvature of the left bank and provided a 600-ft-wide channel through the reach.

Results

Water-surface elevations. Water-surface elevations measured with Plan I are shown in Table 17. These data show that the slopes in water-surface elevations are generally the same as with Plan H-5. The slopes in water-surface elevations varied from less than 0.1 to 1.5 ft per mile upstream of the dam with the 20,000- and the 142,000-cfs riverflows, respectively. The slopes in water-surface elevation downstream of the dam varied from 0.1 to 0.9 ft per mile with the 20,000- and 142,000-cfs riverflows, respectively. The drop through the dam was 0.1 ft with the 142,000-cfs uncontrolled riverflow.

Table 17
Water-Surface Elevations, Plan I

	Water-Surface Elevations for Discharge in 1,000 cfs				
Gauge No.	20	60	80	100	142
1	95.1	94.6	90.0	91.7	96.0
2	95.1	94.5	89.8	91.5	95.5
3	95.1	94.4	89.7	91.3	95.2
4	95.1	94.3	89.6	90.9	94.9
5	95.1	94.2	88.4	89.7	93.4
6	95.0	94.1	88.4	89.4	93.0
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	92.4
Axis of Dam					
8	70.2	80.3	83.7	86.4	92.3
9	70.1	79.9	83.1	85.8	91.7
10	70.1	79.8	83.1	85.7	91.6
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.2	0.8	1.1	1.5
Gauges 8-11	0.1	0.6	0.8	0.9	0.9

[1] Controlled elevations.

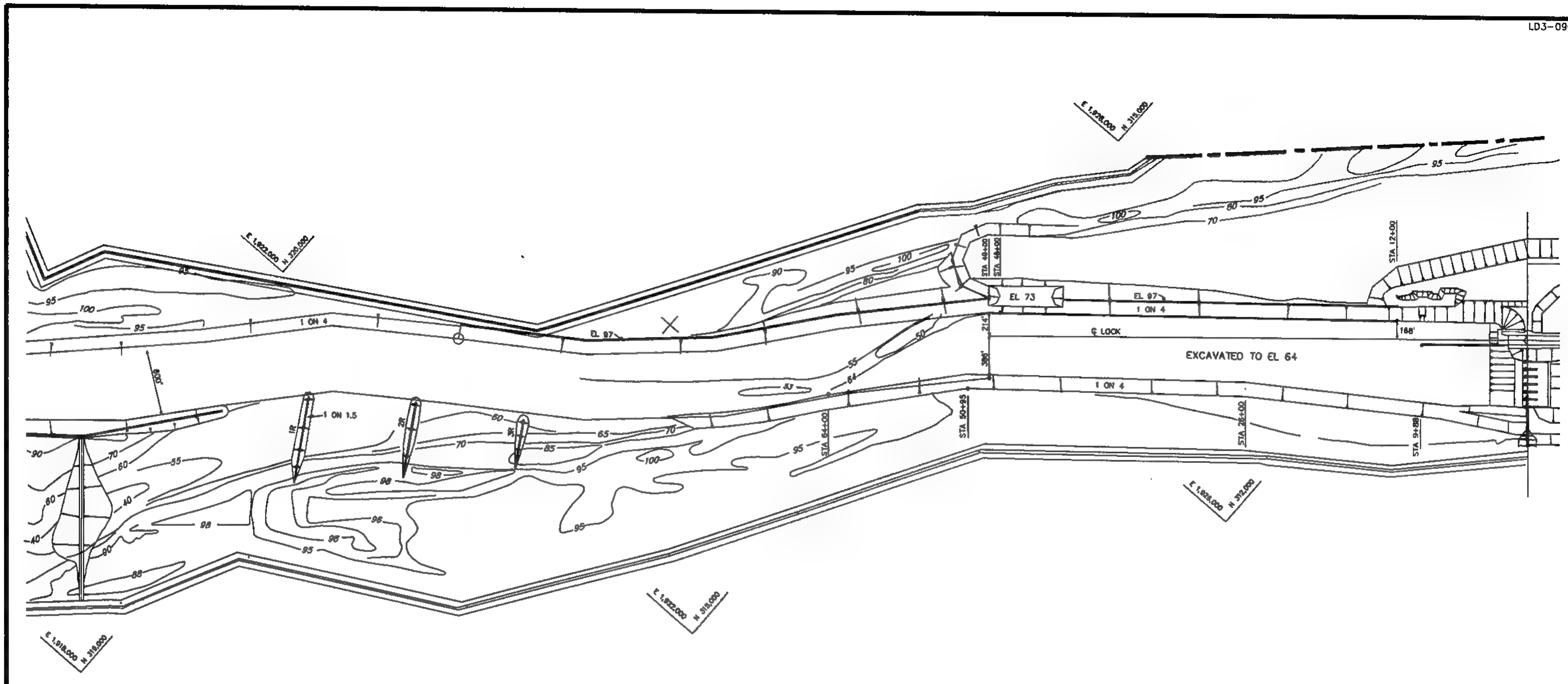
Current directions and velocities. Current direction and velocities data measured with Plan I are shown in Plates 97 and 98. These data show that the currents were generally parallel with the left descending bank from the upstream end of the model to the upper lock approach. With the 142,000-cfs riverflow a large counterclockwise eddy formed between the upper guard wall and the left bank. The maximum velocities of the currents upstream of the dam varied from 4.8 to 7.8 fps, 6,400 ft upstream of the dam; 8.5 to 12.3 fps, 4,800 ft upstream of the dam; and 7.9 to 10.7 fps, 1,500 ft upstream of the dam with the 80,000- and 142,000-cfs riverflows, respectively. This indicates an increase in the velocities of the currents of about 1.0 fps compared with Plans G-3 and G-4. The maximum velocities of the currents approaching the guard wall varied from 6.1 to 10.7 fps with the 80,000- and 142,000-cfs riverflows. This compares with 5.1 to 7.1 fps with Plan G-3.

Navigation conditions. Navigation conditions were satisfactory for tows entering and leaving the upper lock approach with riverflows of 60,000 cfs and below. Downbound tows could drive along the left bank from the upstream end of the model to a point two or three tow lengths upstream of the upper guard wall, start reducing speed, and approach the guard wall with good alignment at a safe speed. Upbound tows could move away from the guard wall and navigate upstream without any major difficulty. As the riverflow increased to 80,000 cfs and the velocities of the currents approaching the lock increased to above 8.0 fps, the tow would experience some difficulty navigating the reach. The alignment of the navigation channel and the currents were satisfactory for downbound tows to make a good approach to the lock. With riverflows of 80,000 and 142,000 cfs, a downbound tow could drive along the left bank from the upstream end of the model to a point two or three tow lengths upstream of the guard wall, start reducing speed, and enter the lock forebay with good alignment (Photos 9 and 10). However, the tow could have difficulty reducing speed and entering the lock forebay at a safe speed. As the head of the tow reached the midpoint of the guard wall, there was a tendency for the head of the tow to be pulled into the guard wall with considerable force. With riverflows of 80,000 cfs and above, an upbound tow experienced some difficulty moving the head of the tow away from the guard wall due to the high velocities of the currents. If the tow had sufficient power to move the head of the tow away from the guard wall and move upstream against the high-velocity currents, it could navigate the reach without any major difficulty (Photos 11 and 12).

Plan I-1

Description

Plan I-1 (Figure 26 and Photo 13) was the same as Plan I except that the el 78.0 berm along the right bank of the excavated channel approaching the lock and dam was removed to el 64.0. This provided a minimum channel width of 600 ft at el 64.0 approaching the lock and dam.



NOTE: ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

DIKE LOCATIONS

DIKE NO.	COORDINATE	AZIMUTH	TOP EL
1R	E 1,921,297.22 N 319,071.68	239D07'22"	EL 97.0
2R	E 1,921,922.30 N 318,290.25	239D07'22"	EL 97.0
3R	E 1,922,460 91 N 317,434.17	239D07'22"	EL 97.0

SCALES

PROTOTYPE 500 0 500 1000 1500 2000

MODEL 5 0 5 10 15 20

Figure 26. Plan I-1

Results

Water-surface elevations. Water-surface elevations measured with Plan I are shown in Table 18. These data show that the slopes in water-surface elevations are generally the same as with Plan I except upstream of the dam with the 142,000-cfs riverflow. The slopes in water-surface elevations varied from less than 0.1 to 1.2 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The slopes in water-surface elevation downstream of the dam varied from 0.1 to 0.9 ft per mile with the 20,000- and 142,000-cfs riverflows, respectively. The drop through the dam was 0.2 ft with the 142,000-cfs uncontrolled riverflow.

Table 18
Water-Surface Elevations, Plan I-1

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs				
	20	60	80[1]	100	142[1]
1	95.1	94.6	89.8	91.7	95.6
2	95.1	94.5	89.6	91.5	95.3
3	95.1	94.4	89.5	91.3	95.1
4	95.1	94.3	89.2	90.9	94.5
5	95.1	94.2	88.7	89.7	94.0
6	95.0	94.1	88.4	89.4	93.4
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	92.5
Axis of Dam					
8	70.2	80.3	83.7	86.4	92.3
9	70.1	79.9	83.1	85.8	91.7
10	70.1	79.8	83.1	85.7	91.6
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/min				
Gauges 1-7	< 0.1	0.2	0.7	1.1	1.2
Gauges 8-11	0.1	0.6	0.8	0.9	0.9

[1] Controlled elevations.

Current directions and velocities. Current direction and velocities data measured with Plan I-1 are shown in Plates 99-102. These data show that the alignment of the currents was generally the same as with Plan I. The currents were generally parallel with the left descending bank from the upstream end of the model to the upper lock approach. The maximum velocities of the currents upstream of the dam varied from 5.0 to 7.8 fps, 6,400 ft upstream of the dam; 7.3 to 9.7 fps, 4,800 ft upstream of the dam; and 6.8 to 8.9 fps, 1,500 ft upstream of

the dam with the 80,000- and 142,000-cfs riverflows, respectively (Plates 100-102). This indicates a significant decrease in the velocities of the currents 4,800 and 1,500 ft upstream of the dam compared with Plan I. With the 60,000-cfs riverflow (Plate 99), the maximum velocities of the currents were about 3.5 fps, 6,400 ft upstream of the dam; 4.3 fps, 4,800 ft upstream of the dam; and 3.9 fps, 1,500 ft upstream of the dam. The maximum velocities of the currents approaching the guard wall varied from 4.6 to 7.7 fps with the 80,000- and 142,000-cfs riverflows. This compares with 6.1 to 10.7 fps with Plan I.

Navigation conditions. With the higher riverflows, navigation conditions were considerably better than with Plan I due to the velocities of the currents approaching the lock being 1.0 to 3.0 fps less with Plan I-1. With all riverflows, downbound tows could drive along the left bank from the upstream end of the model to a point two or three tow lengths upstream of the guard wall, start reducing speed, and enter the lock forebay with good alignment (Photos 14-16). As the riverflow increased to 100,000 cfs and the velocities of the currents approaching the lock increased to above 8.0 fps, tows would experience some difficulty navigating the reach. A downbound tow would have difficulty reducing speed and entering the lock forebay at a safe speed, and an upbound tow would have some difficulty moving the head of the tow away from the wall. If the tow had sufficient power to move the head of the tow away from the guard wall and move upstream against the high-velocity currents, it could navigate the reach without any major difficulty (Photos 17-19).

Plan I-2

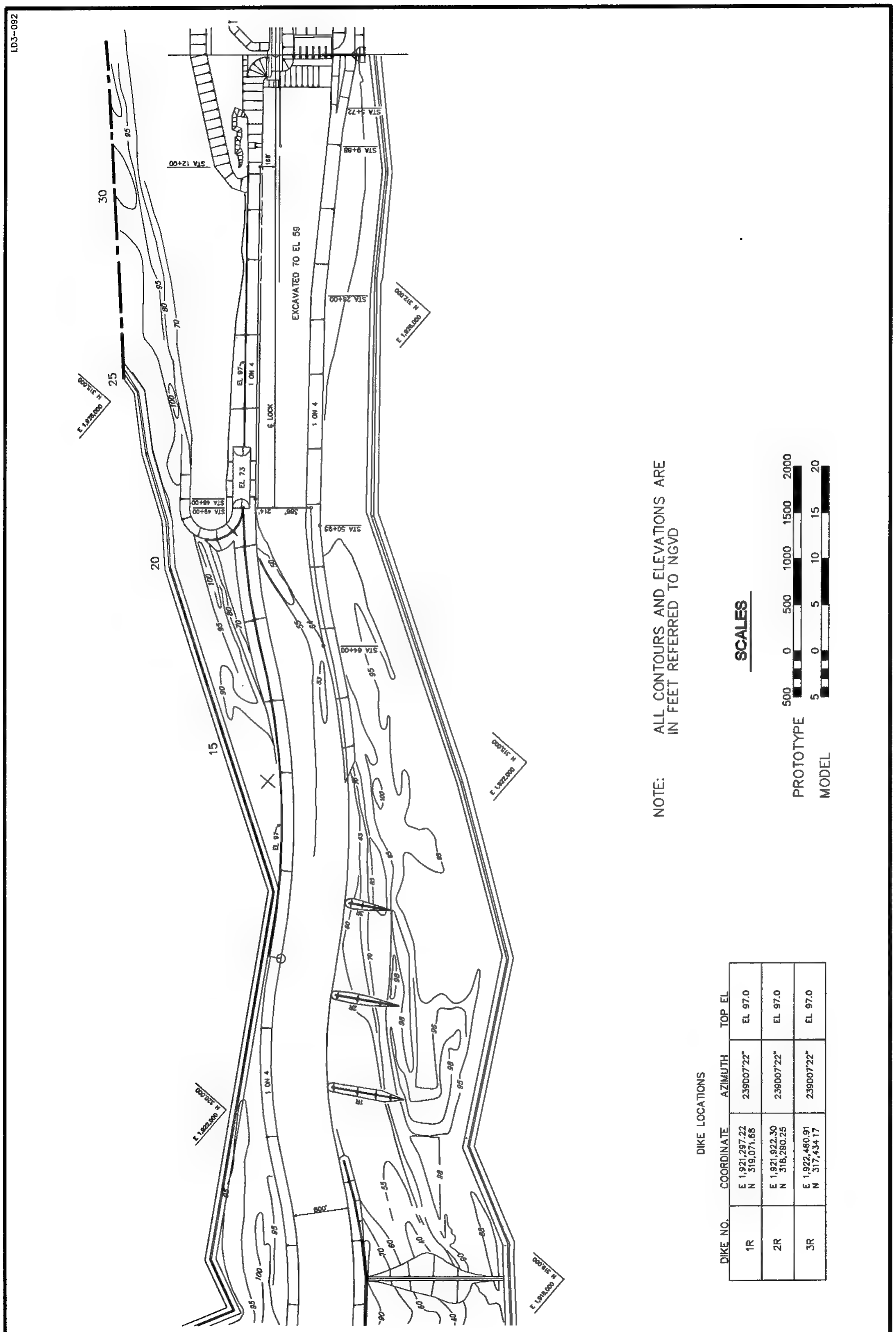
Description

Data collected with Plans I and I-1 show that the velocities of the currents approaching the lock are high. Therefore, to reduce the velocities of the currents and improve navigation conditions for tows entering and leaving the lock, the bottom of the excavated channel approaching the lock and dam was lowered from el 64.0 to el 59.0. This plan was designated Plan I-2 (Figure 27).

Results

Water-surface elevations. Water-surface elevations measured with Plan I-2 are shown in Table 19. These data show a slight decrease in the slopes in water-surface elevations upstream of the dam. The slopes in water-surface elevations varied from less than 0.1 to 1.0 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The slopes in water-surface elevation downstream of the dam varied from 0.1 to 0.9 ft per mile with the 20,000- and 142,000-cfs riverflows, respectively. The drop through the dam was 0.2 ft with the 142,000-cfs uncontrolled riverflow.

Current directions and velocities. Current direction and velocities data measured with Plan I-2 are shown in Plates 103-105. These data show that the



DIKE NO.	COORDINATE	AZIMUTH	TOP EL
1R	E 1,921,297.22 N 319,071.68	239D07'22"	EL 97.0
2R	E 1,921,922.30 N 318,280.25	239D07'22"	EL 97.0
3R	E 1,922,460.91 N 317,434.17	239D07'22"	EL 97.0

Figure 27. Plan I-2

Table 19
Water-Surface Elevations, Plan I-2

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs				
	20	60	80	100	142
1	95.1	94.6	89.0	91.7	94.9
2	95.1	94.5	88.8	91.5	94.6
3	95.1	94.4	88.7	91.3	94.4
4	95.1	94.3	88.5	90.9	93.7
5	95.1	94.2	88.3	89.7	93.5
6	95.0	94.1	88.1	89.4	93.1
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	92.5
Axis of Dam					
8	70.2	80.3	83.7	86.4	92.3
9	70.1	79.9	83.1	85.8	91.7
10	70.1	79.8	83.1	85.7	91.6
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/min				
Gauges 1-7	< 0.1	0.2	0.4	1.0	1.0
Gauges 8-11	0.1	0.6	0.8	0.9	0.9

[1] Controlled elevations.

alignment of the currents was generally the same as with Plan I-2. However, the velocities of the currents were somewhat less. The maximum velocities of the currents upstream of the dam varied from 3.3 to 8.5 fps, 6,400 ft upstream of the dam; 3.8 to 8.5 fps, 4,800 ft upstream of the dam; and 3.5 to 8.2 fps, 1,500 ft upstream of the dam with the 60,000-, 80,000-, and 142,000-cfs riverflows, respectively. The maximum velocities of the currents approaching the guard wall varied from 3.3 to 7.0 fps with the 60,000- and 142,000-cfs riverflows, respectively. This compares with 3.2 to 7.7 fps with Plan I-1.

Navigation conditions. Navigation conditions were generally the same as with Plan I-1. Downbound tows could approach the lock forebay with good alignment but would have difficulty approaching the guard wall at a safe speed. Upbound tows would have some difficulty moving the head of the tow away from the guard wall.

Plan I-3

Description

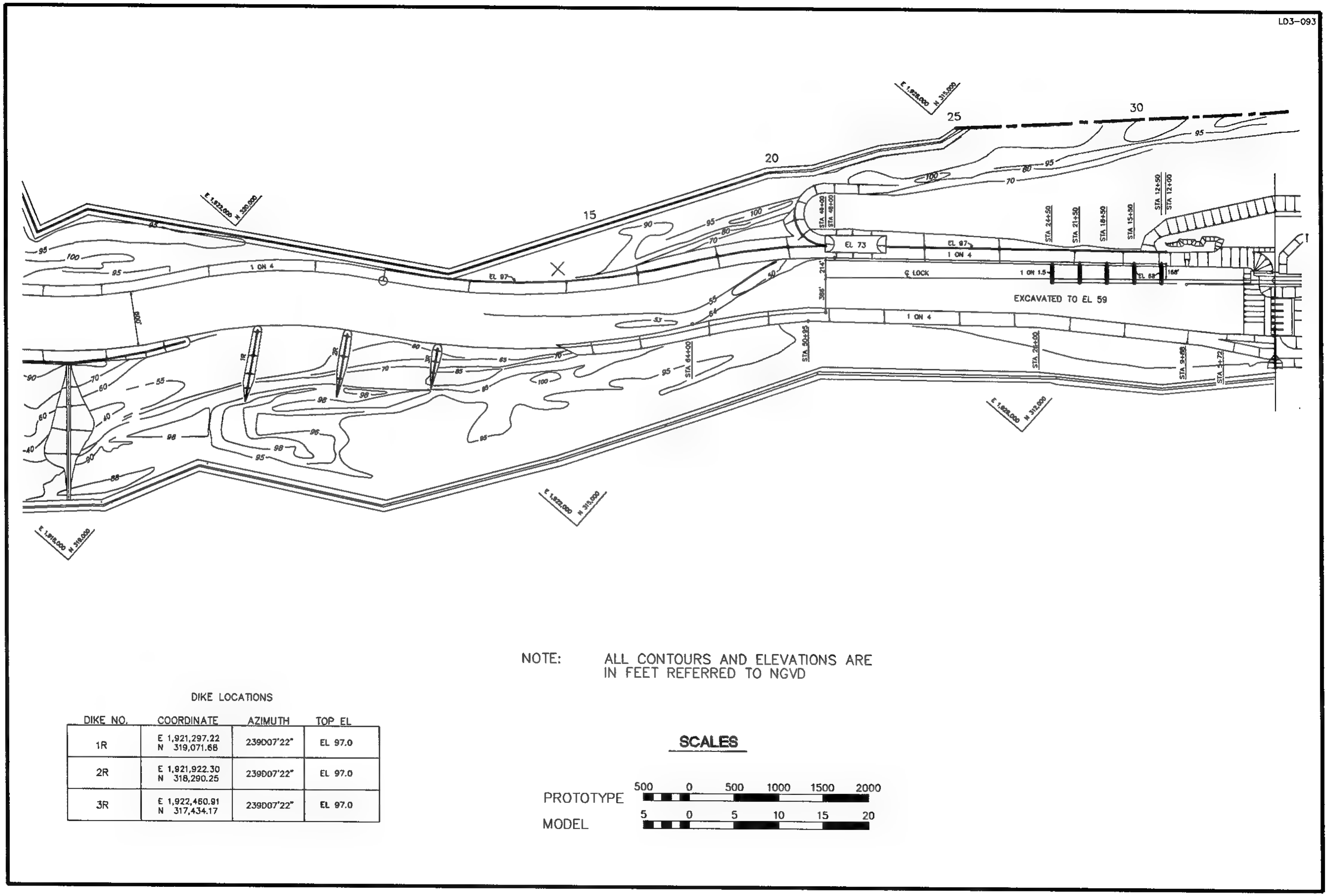
Plan I-3 (Figure 28) was the same as Plan I-2 except that five submerged dikes with top elevation of 68.0 were added in the upper approach to the lock. The dikes were spaced 300 ft apart and located at sta 12+50, 15+50, 18+50, 21+50, and 24+50. The riverward ends of the dikes were in line with the upper guard wall of the lock and the landward ends tied into the left bank. The spacing and height of the dikes were designed to reduce the velocities of the currents entering the lock forebay and to allow a tow to ride on top of the dike field when entering and leaving the lock forebay.

Results

Water-surface elevations. Water-surface elevations measured with Plan I-3 are shown in Table 20. These data show that the slopes in water-surface elevations were generally the same as with Plan I-2. The slopes in water-surface elevations varied from less than 0.1 to 1.0 ft per mile upstream of the dam with the 20,000- and 142,000-cfs riverflows, respectively. The slopes in water-surface elevation downstream of the dam varied from 0.1 to 0.9 ft per mile with the 20,000- and 142,000-cfs riverflows, respectively. The drop through the dam was 0.2 ft with the 142,000-cfs uncontrolled riverflow.

Current directions and velocities. Current direction and velocities data measured with Plan I-2 are shown in Plates 106-108. These data show that the alignment of the currents was generally the same as with Plan I-2. The maximum velocities of the currents upstream of the dam varied from 3.6 to 8.4 fps, 6,400 ft upstream of the dam; 3.9 to 9.7 fps, 4,800 ft upstream of the dam; and 3.9 to 8.2 fps, 1,500 ft upstream of the dam with the 60,000-, 80,000-, and 142,000-cfs riverflows, respectively. The maximum velocities of the currents approaching the guard wall varied from 2.6 to 5.6 fps with the 60,000- and 142,000-cfs riverflows, respectively. This compares with 3.3 to 7.0 fps with Plan I-2.

Navigation conditions. Navigation conditions for tows approaching the lock forebay were generally the same as with Plan I-2. However, with the higher riverflows, the dike field improved navigation conditions for tows entering and leaving the lock. With riverflows of 100,000 cfs and less, downbound tows could drive along the left bank from the upstream end of the model to the dike field, start reducing speed, and enter the lock forebay at a safe speed. The tow could approach the guard wall with more control than with Plan I-2. Upbound tows could move the head of the tow away from the guard wall and move upstream without any major difficulty.



DIKE NO.	COORDINATE	AZIMUTH	TOP EL
1R	E 1,921,297.22 N 319,071.68	239D07'22"	EL 97.0
2R	E 1,921,922.30 N 318,290.25	239D07'22"	EL 97.0
3R	E 1,922,460.91 N 317,434.17	239D07'22"	EL 97.0

Figure 28. Plan I-3

Table 20
Water-Surface Elevations, Plan I-3

Gauge No.	Water-Surface Elevations for Discharge in 1,000 cfs				
	20	60[1]	80[1]	100	142[1]
1	95.1	94.6	89.1	91.7	94.9
2	95.1	94.5	89.0	91.5	94.6
3	95.1	94.4	88.9	91.3	94.4
4	95.1	94.3	88.5	90.9	93.8
5	95.1	94.2	88.3	89.7	93.5
6	95.0	94.1	88.2	89.4	93.2
7	95.0[1]	94.0[1]	88.0[1]	89.0[1]	92.5
Axis of Dam					
8	70.2	80.3	83.7	86.4	92.3
9	70.1	79.9	83.1	85.8	91.7
10	70.1	79.8	83.1	85.7	91.6
11	70.1[1]	79.8[1]	83.0[1]	85.6[1]	91.5[1]
	Slope, ft/mile				
Gauges 1-7	< 0.1	0.2	0.4	1.0	1.0
Gauges 8-11	0.1	0.6	0.8	0.9	0.9

[1] Controlled elevations.

Guard Wall Performance Experiments

Description

Plan I-1 was selected by the Vicksburg District as the preferred plan based on information from the navigation model, movable-bed model, large-scale structure model, and design limitations from the project. Due to limitations on when the design pool of el 95.0 could be established, the Vicksburg District requested experiments to evaluate the performance of the upper guard wall during an interim pool el 85.5. Therefore, guard wall performance experiments were conducted with the model controlled to an interim pool elevation of 85.5 and Plan I-1 conditions. In addition to the features shown in Figure 26, three closure blocks were placed in each of the three most downstream full guard wall ports. These closure blocks were 8 ft wide by 12 ft deep by 10 ft high. The elevation of the top of the guard wall ports was at el 78.0. With the 80,000-cfs riverflow and an upper pool el 88.0, which is the maximum drawdown riverflow under normal operating conditions, the top of guard wall ports was 1.0 ft below the bottom of a barge drafting 9.0 ft (design draft for a loaded barge). Maintaining the upper pool at el 85.5 placed the bottom of a loaded barge 1.5 ft below the top

of the guard wall ports and placed the barge directly in the port flows. All tow experiments were conducted with the upper pool controlled at the interim pool elevation of 85.5 except with the 100,000-cfs riverflow, which was also operated with pool elevation of 89.0 to provide a comparison between the interim pool operation and completed project operation. The 100,000-cfs riverflow was selected for the comparison because it provided the highest discharge for the interim pool elevation of 85.5. A model towboat with barges representing three tow sizes was used to evaluate the effects of the currents on tows entering and leaving the lock and the maneuvering required for an upbound tow to move away from the guard wall. The three sizes of tows used were six 35- by 195-ft barges, representing a tow 70 ft wide by 585 ft long; four 35- by 195-ft barges, representing a tow 70 ft wide by 390 ft long; and three 35- by 195-ft barges, representing a tow 35 ft wide by 585 ft long. The riverflows used for the experiments were 40,000, 60,000, 80,000, and 100,000 cfs. Evaluation of these conditions is based on the following:

a. Current direction and velocities data.

b. Observation of dye and confetti showing current patterns in the upper lock approach.

c. Observation of the path of the tow entering and leaving the lock.

d. Tow maneuvering experiments.

e. Drift experiments of static tows placed in the upper lock approach.

Results of experiments with Plan I-1 and interim pool operation

Current directions and velocities. Current direction and velocities data measured with interim pool conditions and Plan I-1 are shown in Plates 109-112. These data show that with an upper pool elevation of 85.5, the maximum velocities of the currents entering the upper lock approach immediately upstream of the upstream end of the guard wall were about 3.6, 5.4, 6.8, and 8.1 fps with the 40,000-, 60,000-, 80,000-, and 100,000-cfs riverflows, respectively. This compares to maximum velocities of about 2.8, 3.2, 4.6, and 5.2 fps with 40,000-, 60,000-, 80,000-, and 100,000-cfs riverflows controlled to the normal project pool. This indicates an increase in the velocities of the currents entering the lock approach of about 30.8 percent and 55.8 percent with the 80,000- and 100,000-cfs riverflows, respectively, when compared with the 100,000-cfs riverflow with upper pool el 89.0.

Static tow experiments. Static tow drift experiments were conducted by placing a tow in the upper lock approach 50 ft landward of and parallel to the guard wall with the head of the tow 50 ft upstream of the landside lock wall, releasing the tow, and recording the time required for the tow to move to the guard wall. The results of these experiments are shown in Table 21. Using these data and the mass of the tow, the momentum of the tow was calculated and is shown in Table 22. The mass of the barges was computed based on a block

Table 21
Static Tow Releases in the Upper Lock Approach,[1] Plan I-1

Discharge cfs	Operational Procedure		Tow Size No. of Barges[2]	Elapsed Time in Seconds Release to Guard Wall	
	Upper Pool El	Gates Passing Flow		Bow	Stern
40,000	85.5	1-6	6		115.4
	85.5	1-6	4		109.3
	85.5	1-6	3		125.0
60,000	85.5	1-6	6	109.3	106.6
	85.5	1-6	4		104.6
	85.5	1-6	3	91.2	70.3
	85.5	4, 5, & 6	6	139.0	108.0
	85.5	4, 5, & 6	4	138.3	96.5
	85.5	4, 5, & 6	3	98.5	78.2
	88.0	1-6	6		173.9
	88.0	1-6	4	220.4	118.9
	88.0	1-6	3	180.7	108.2
80,000	85.5	1-6	6	80.1	87.4
	85.5	1-6	4	79.4	70.1
	85.5	1-6	3	61.2	63.3
	85.5	3-6	6	80.0	84.1
	85.5	3-6	4	90.0	70.2
	85.5	3-6	3	72.6	69.5
	85.5	3-6	6	80.0	84.1
	85.5	3-6	4	90.0	70.2
	85.5	3-6	3	72.6	69.5
100,000	85.5	Open river	6	64.5	77.8
	85.5	Open river	4	58.3	53.3
	85.5	Open river	3	53.3	59.3
	89.0[3]	3-6	6	78.8	77.8
	89.0	3-6	4	87.6	61.3
	89.0	3-6	3	72.2	69.4

Note: Three 8- by 12- by 10-ft-high blocks were in place in each of the three most downstream full guard wall ports.

[1] Tow placed 50 ft landward of and parallel to guard wall with head of tow 50 ft upstream of landside lock wall.

[2] Six barges: two wide by three long (35- by 195-ft barges).
Four barges: two wide by two long.
Three barges: one wide by three long.

[3] Project pool.

Table 22
Static Tow Momentum in the Upper Lock Approach,[1] Plan I-1

Discharge, cfs	Operational Procedure: Upper Pool, El	Operational Procedure: Gates Passing Flow	Tow Size No. of Barges[2]	Momentum Slug-ft per sec
40,000	85.5	1-6	6	309,000
	85.5	1-6	4	218,000
	85.5	1-6	3	143,000
60,000	85.5	1-6	6	331,000
	85.5	1-6	4	228,000
	85.5	1-6	3	221,000
	85.5	4, 5, & 6	6	289,000
	85.5	4, 5, & 6	4	203,000
	85.5	4, 5, & 6	3	202,000
	88.0	1-6	6	205,000
	88.0	1-6	4	140,000
	88.0	1-6	3	124,000
80,000	85.5	1-6	6	426,000
	85.5	1-6	4	318,000
	85.5	1-6	3	287,000
	85.5	3-6	6	435,000
	85.5	3-6	4	297,000
	85.5	3-6	3	251,000
100,000	85.5	Open river	6	502,000
	85.5	Open river	4	427,000
	85.5	Open river	3	317,000
	89.0[3]	1-6	6	456,000
	89.0	1-6	4	320,000
	89.0	1-6	3	252,000

Note: Three 8- by 12- by 10-ft-high blocks were in place in each of the three most downstream full guard wall ports.
[1] Tow placed 50 ft landward of and parallel to guard wall with head of tow 50 ft upstream of landside lock wall.
[2] Six barges: two wide by three long (35- by 195-ft barges).
Four barges: two wide by two long.
Three barges: one wide by three long.
[3] Project pool.

coefficient of 1.0, i.e., no bow or stern rake. These data indicate that when compared with the forces on a tow with the 100,000-cfs riverflow at normal pool el 89.0, the forces acting to pull the tow toward the guard wall when the pool is at interim pool of 85.5 ft will be

a. Much stronger with a riverflow of 100,000 cfs.

b. About the same with a riverflow of 80,000 cfs.

c. Less with a riverflow of 60,000 cfs.

To determine if the operation of the structure could decrease the forces acting on a tow in the upper lock approach, the gates adjacent to the lock were used to control the pool. Gate one, the gate adjacent to the lock, was used to control the pool until it was closed; then gate two was used for control. This sequence was continued across the dam. Current directions and velocities shown in Plate 113 indicate that the gate operation reduced the velocities of the currents in the lock approach slightly with the 60,000-cfs riverflow but had little, if any, effect on the velocities of the currents with the 80,000-cfs riverflow (compare Plates 110 and 111 with Plate 113). Observation of dye and confetti, along with operation of the model tow, indicated that the gate operation did not significantly increase the crosscurrent near the upstream end of the guard wall. Static tow drift data were collected with these conditions and are shown in Tables 21 and 22. These data indicate that using the gates adjacent to the dam could reduce the forces acting on the tow with the 60,000-cfs riverflow, but the forces would remain about the same with the 80,000-cfs riverflow. The 100,000-cfs riverflow was uncontrolled with no gate operations. Current directions and velocities data taken with the 60,000-cfs riverflow and an upper pool elevation of 88.0 (originally proposed interim pool) are shown in Plate 114.

Navigation conditions. Experiments indicate that operating the pool at an interim elevation of 85.5 will have an adverse effect on navigation. Tow maneuvering experiments indicate that an upbound six-barge tow could push away from the guard wall and move upstream without any difficulty with the 40,000-cfs riverflow and an upper pool elevation of 85.5. As the riverflow increased to 60,000 cfs, an upbound six-barge tow could experience some difficulty pushing away from the guard wall and moving upstream. With all conditions evaluated and all sizes of tows used, downbound tows could enter the lock approach without any difficulty. However, with the higher riverflows and the interim pool, tows would experience difficulty holding the head of the tow away from the guard wall and could hit the wall with considerable force. These data indicate that some of the adverse effects of the interim pool can be mitigated by operation of the gates and/or limiting the size of the tows entering the upper lock approach. Although the data are not conclusive, a three-barge tow would probably experience less difficulty pushing away from the guard wall than a four-barge tow. A three-barge tow could exit the lock chamber along the landside wall of the lock, placing the tow about 49 ft landward of the guard wall. This maneuver should reduce the forces on the tow.

4 Discussion of Results and Conclusions

Limitations of Model Results

Analysis of the results of this investigation is based on a study of (a) the effects of various plans and modifications on water-surface elevations and current directions and velocities and (b) the effects of the resulting currents on model towboat and tow behavior. An evaluation of the results should consider that small changes in current directions and velocities are not necessarily changes produced by a modification in the plan since several floats introduced at the same point may follow a different path and move at somewhat different velocities due to pulsating currents and eddies. Current directions and velocities shown in the plates were obtained with floats submerged to the depth of a loaded barge (8-ft prototype) and are more indicative of currents affecting the behavior of tows than those indicated by photographs, which indicate the movement of confetti on the water surface and could be affected by surface tension.

The small scale of the model made it difficult to reproduce accurately the hydraulic characteristics of the prototype structures or to measure water-surface elevation with an accuracy greater than about ±0.1-ft prototype. Also, current directions and velocities were based on steady riverflows and would be somewhat different with varying riverflows. The model was a fixed-bed type and not designed to reproduce overall sediment movement that might occur in the prototype with the various plans. Therefore, changes in channel configuration resulting from scouring and deposition and any resulting changes in current directions and velocities were not evaluated.

Summary of Results and Conclusions

The following results and conclusions were developed during the investigation:

a. Plan I-3 provided the most satisfactory navigation conditions for tows entering and leaving the upper lock approach without removing revetment 143.0L and moving the levee. Plan I-3 provided an entrance to a

maintenance facility in the existing river channel behind the left bank dike.

b. Plan I-1 provided satisfactory navigation conditions for tows entering and leaving the upper lock approach without removing revetment 143.0L and moving the levee. However, with riverflows of 100,000 cfs and higher, tows could experience some difficulty entering and leaving the lock due to the velocities of the currents.

c. Plan G-4 provided satisfactory navigation conditions for tows entering and leaving the upper lock approach and the lowest velocity currents through the upstream reach of the model. With Plan G-4, revetment 143.0L was removed and the levee was moved. Plan G-4 provided an entrance to a maintenance facility in the existing river channel behind the left bank dike.

d. Plan H-5 provided the most satisfactory navigation conditions for tows entering or leaving the lower lock approach with the range of plans and riverflows evaluated and retaining approximately 110 ft of clearance between the transmission tower and the top of the left bank. However, with riverflows of 80,000 cfs and above, a high-horsepower towboat would be required to navigate the reach due to high velocities of the currents in the navigation channel downstream of the locks.

e. Plan H-4 provided the most satisfactory navigation conditions for tows entering or leaving the lock with the range of riverflows evaluated without removing the transmission tower. However, this plan encroached on the transmission tower and could result in the tower being unstable.

f. With the original design, Plan A, Plan A-Modified, and Plan C, navigation conditions were unsatisfactory to hazardous in the immediate upper lock approach with all riverflows evaluated due to the extreme crosscurrent at the upstream end of the esplanade and at the upstream end of the guard wall. The alignment of the currents was poor throughout the upper reach of the model.

g. With Plan B, navigation conditions were poor with all riverflows due to the difficult crossing between the downstream end of revetment 143.0L and the lock approach. The dike extending upstream from the lock esplanade improved navigation conditions near the upstream end of the guard wall.

h. Plan D provided satisfactory navigation conditions with riverflows of 100,000 cfs and less for tows approaching the lock. However, with the higher riverflows, tows could not approach the guard wall at a safe speed and the head of the tow was pulled to the wall with considerable force.

i. With Plan E, the slopes in water-surface elevations and velocities of currents were very high. Navigation conditions with riverflows of

80,000 cfs and greater were hazardous for downbound tows approaching the lock.

j. Plan F provided good channel alignment for tows entering and leaving the upper lock approach. However, with riverflows of 80,000 cfs and greater, the velocities of the currents increased to a point where tows would have difficulty navigating the reach.

k. Operating the upper pool of the project at el 85.5 will adversely affect navigation. However, some of the adverse effects of the interim pool can be mitigated by operation of the dam gates and/or limiting the size of the tows using the project.

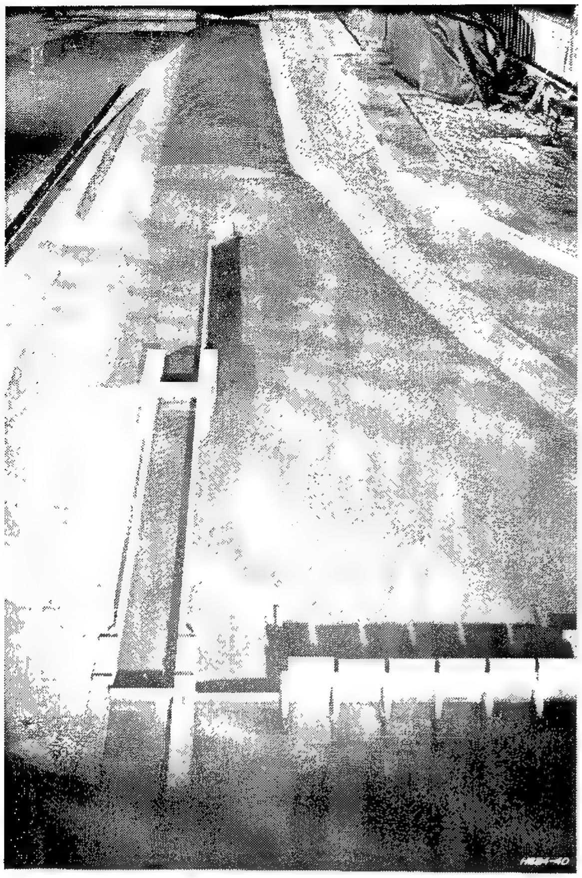


Photo 1. Plan H-5, looking downstream

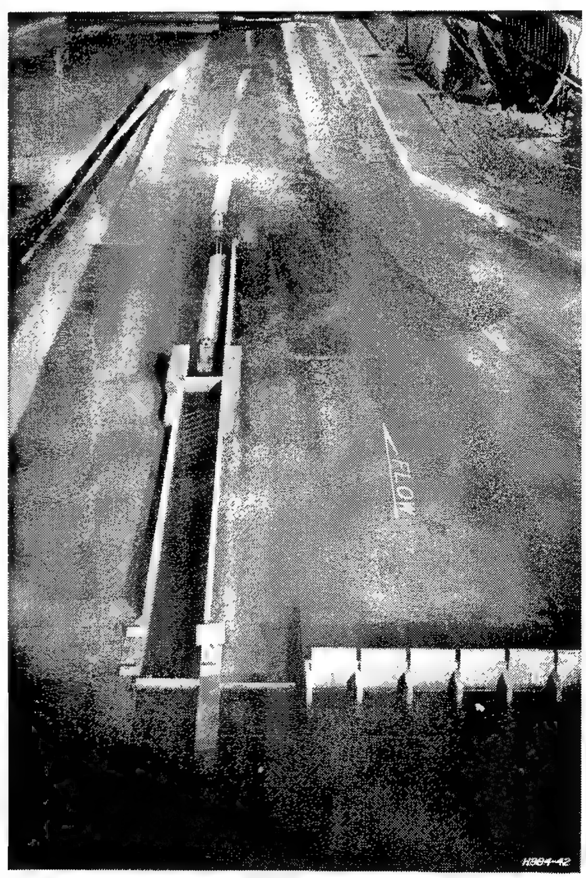


Photo 2. Plan H-5, looking downstream, discharge 20,000 cfs, showing path of downbound tow

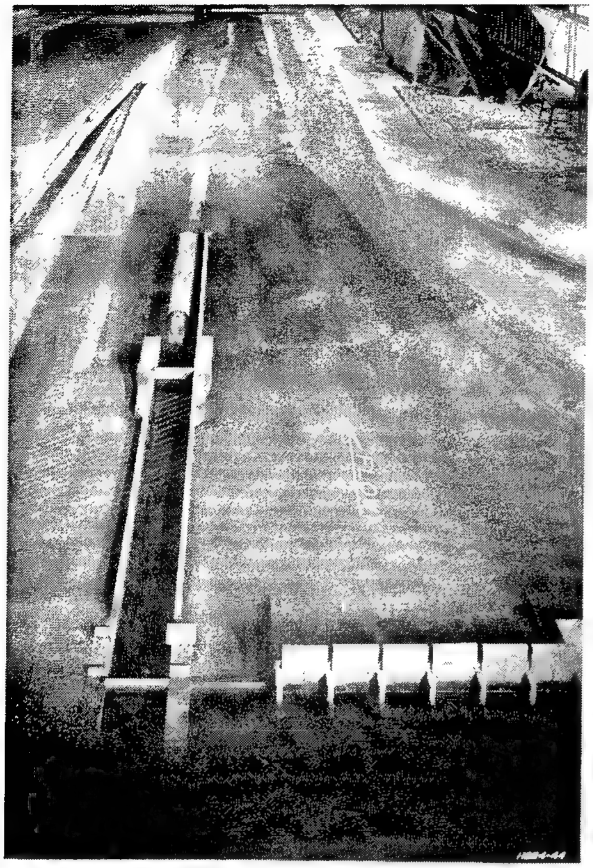


Photo 3. Plan H-5, looking downstream, discharge 60,000 cfs, showing path of downbound tow

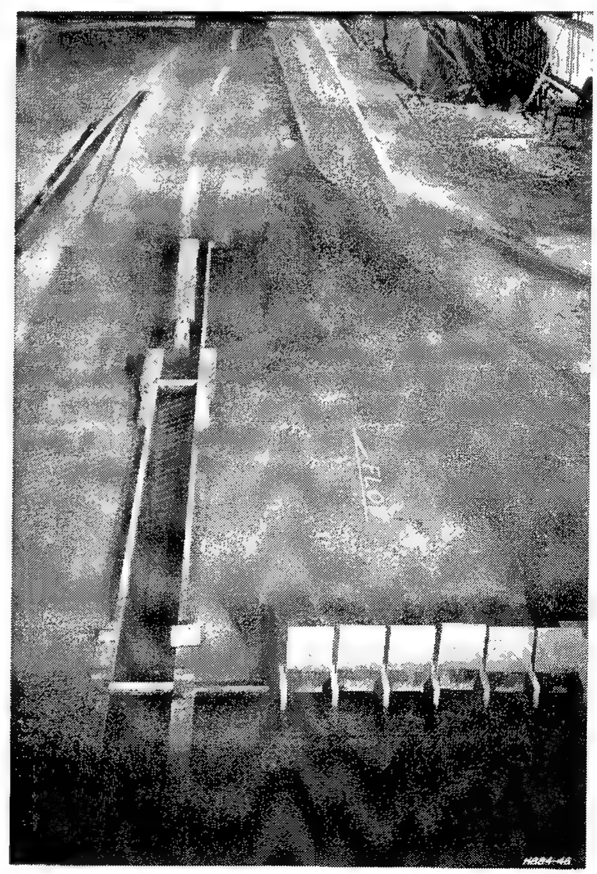


Photo 4. Plan H-5, looking downstream, discharge 142,000 cfs, showing path of downbound tow

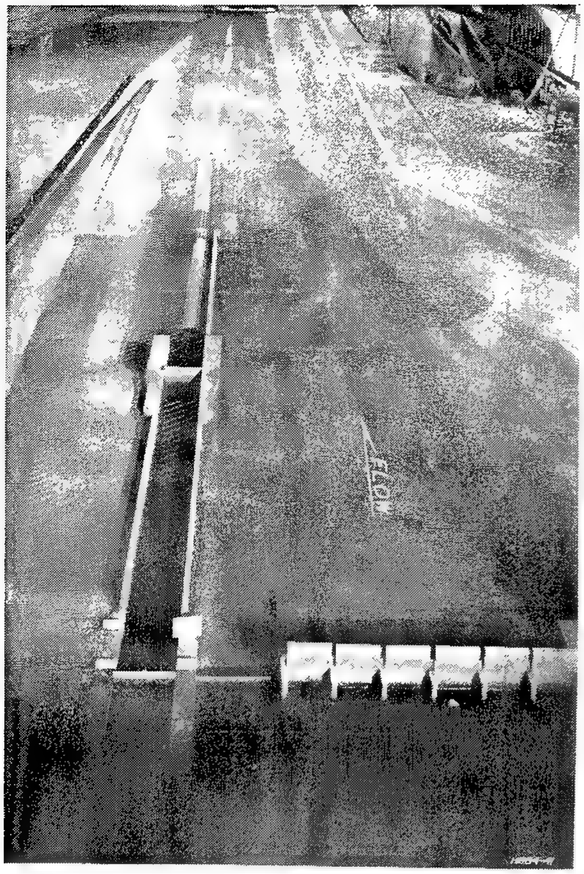


Photo 5. Plan H-5, looking downstream, discharge 20,000 cfs, showing path of upbound tow

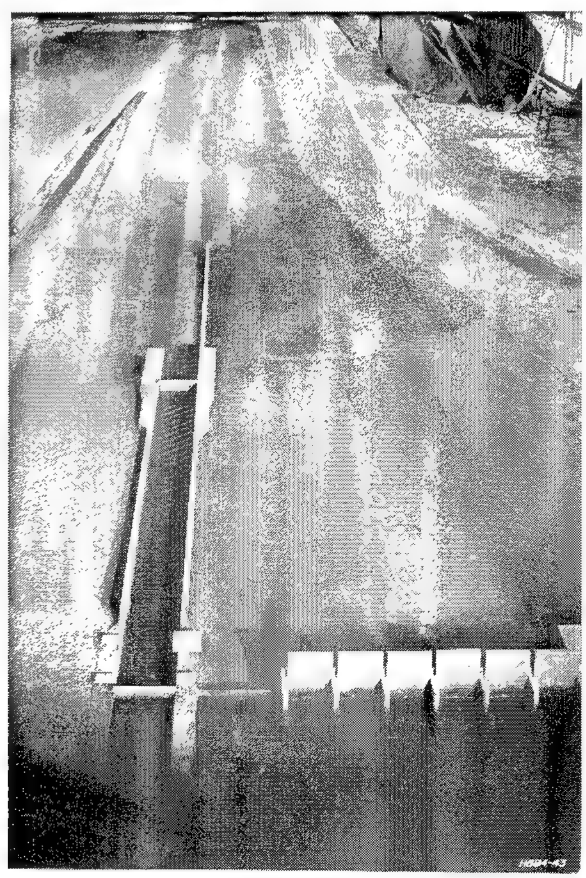


Photo 6. Plan H-5, looking downstream, discharge 60,000 cfs, showing path of upbound tow

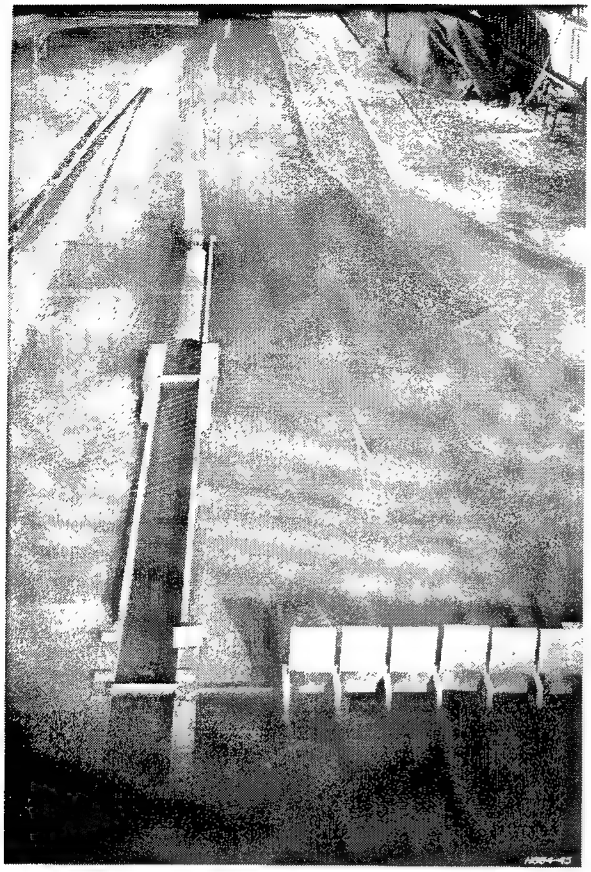


Photo 7. Plan H-5, looking downstream, discharge 142,000 cfs, showing path of upbound tow

Photo 8. Plan I, looking upstream

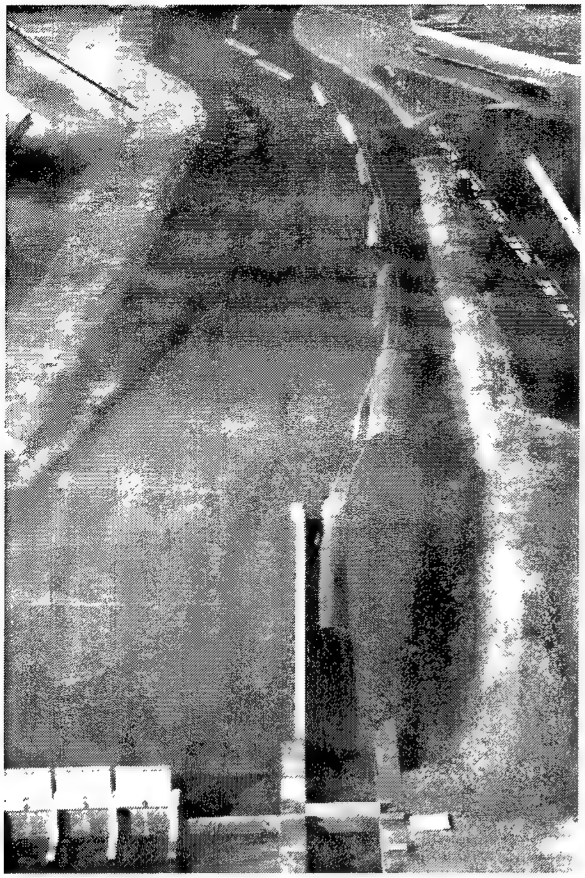


Photo 9. Plan I, looking upstream, discharge 80,000 cfs, showing path of downbound tow

Photo 10. Plan I, looking upstream, discharge 142,000 cfs, showing path of downbound tow

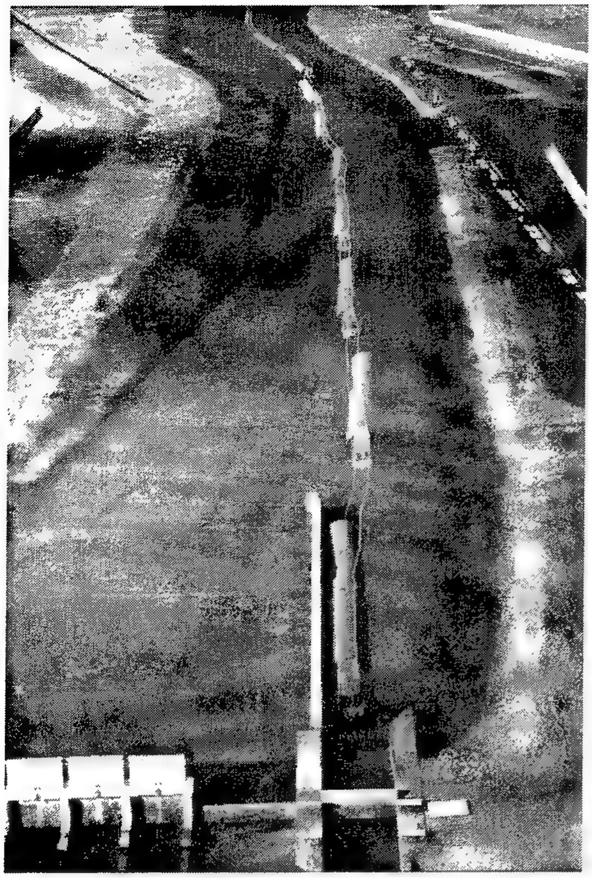


Photo 11. Plan I, looking upstream, discharge 80,000 cfs, showing path of upbound tow

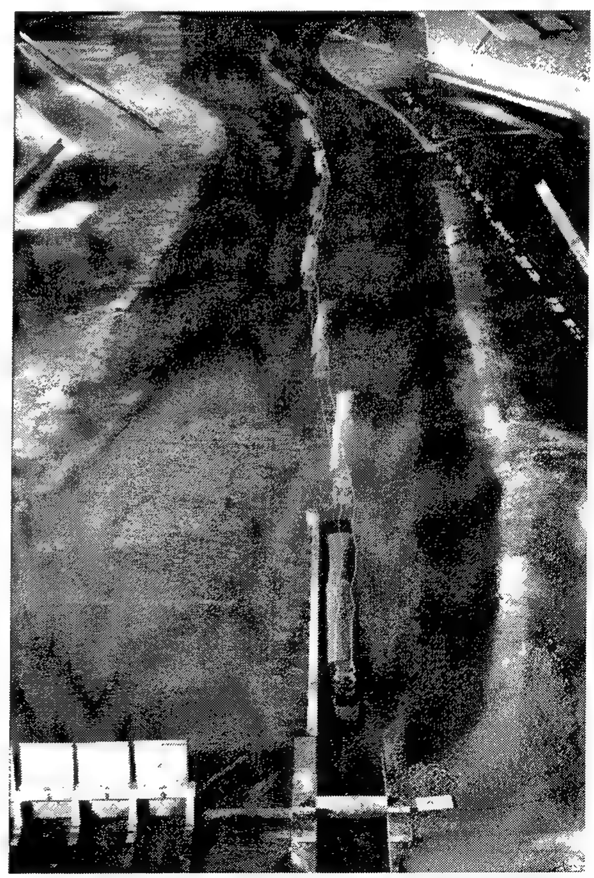


Photo 12. Plan I, looking upstream, discharge 142,000 cfs, showing path of upbound tow

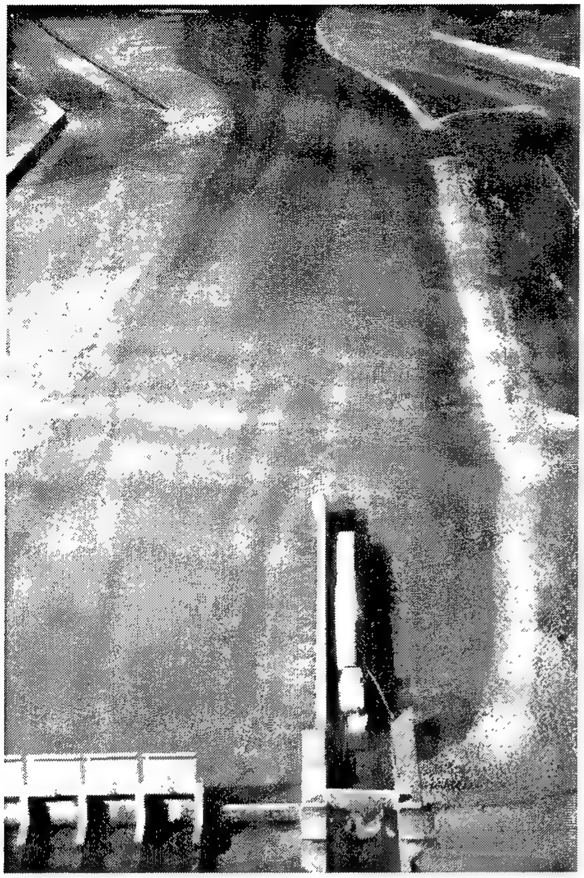


Photo 13. Plan I-1, looking upstream

Photo 14. Plan I-1, looking upstream, discharge 60,000 cfs, showing path of downbound tow

Photo 15. Plan I-1, looking upstream, discharge 80,000 cfs, showing path of downbound tow

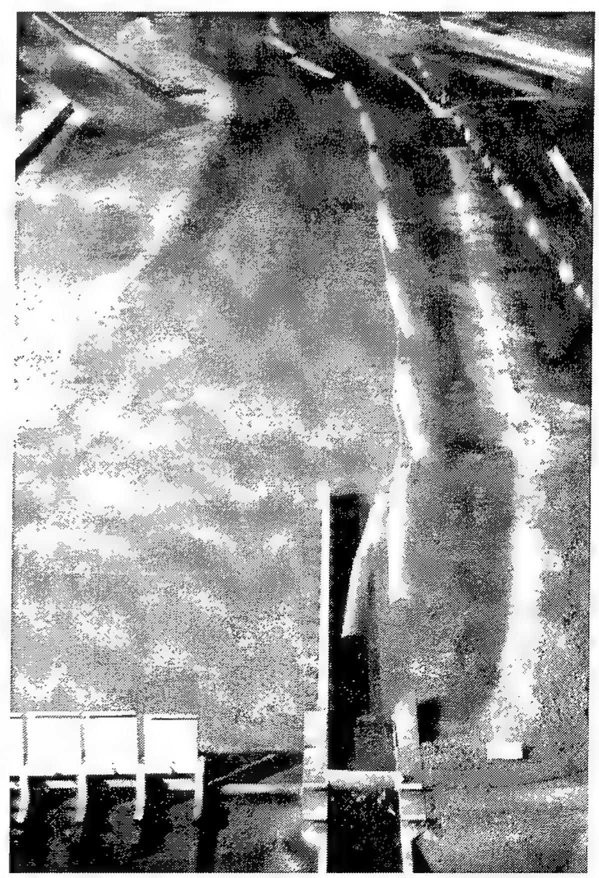


Photo 16. Plan I-1, looking upstream, discharge 142,000 cfs, showing path of downbound tow

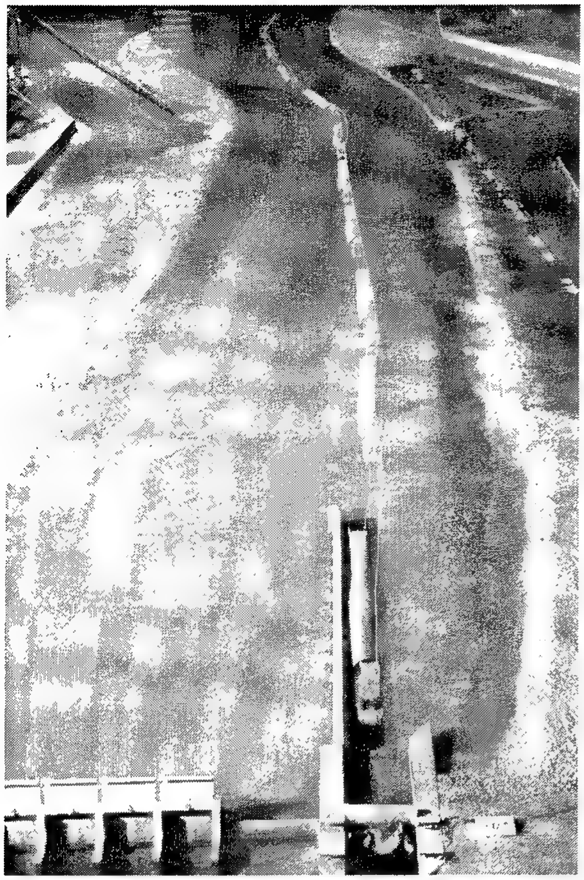


Photo 17. Plan I-1, looking upstream, discharge 60,000 cfs, showing path of upbound tow

Photo 18. Plan I-1, looking upstream, discharge 80,000 cfs, showing path of upbound tow

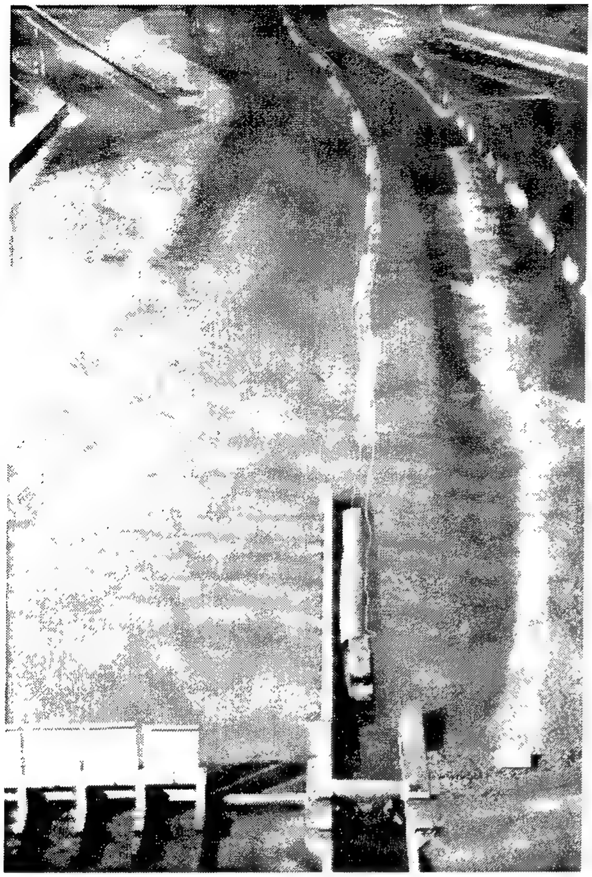
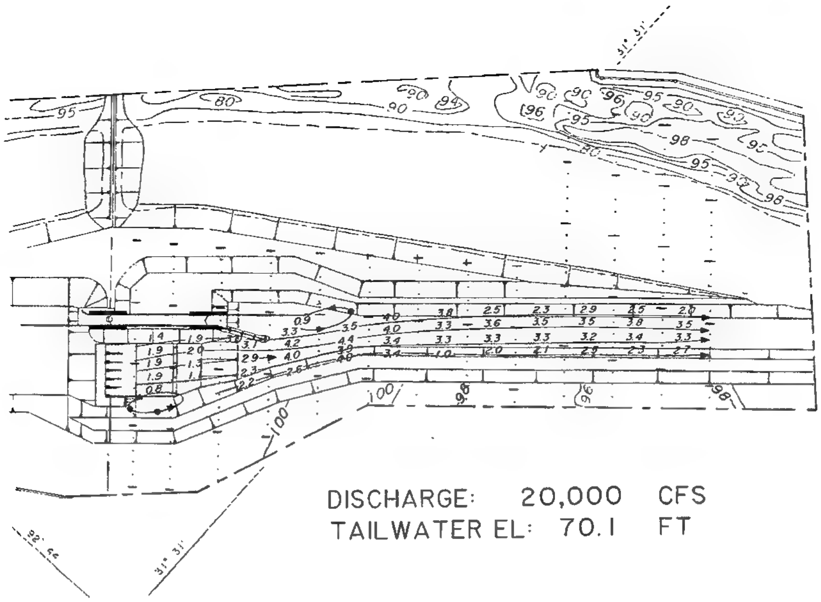
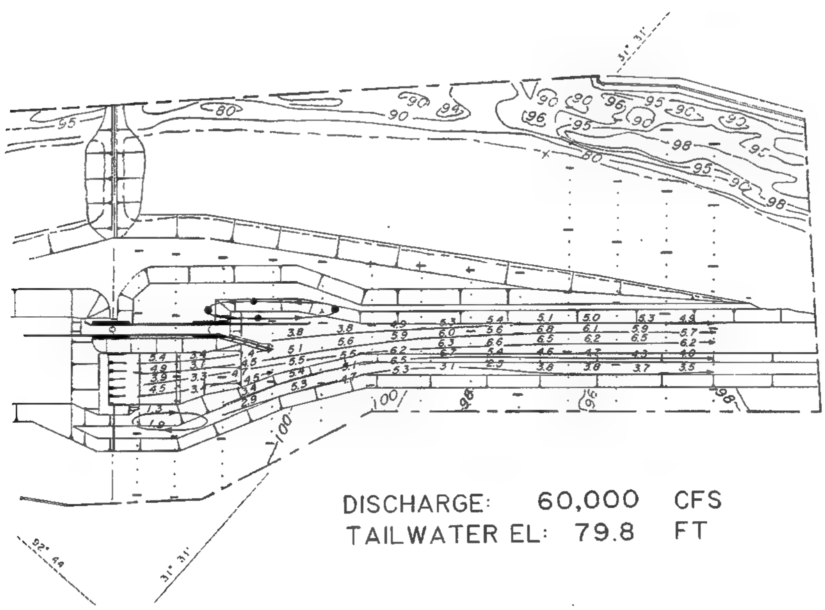


Photo 19. Plan I-1, looking upstream, discharge 142,000 cfs, showing path of upbound tow





LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

ORIGINAL DESIGN

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT

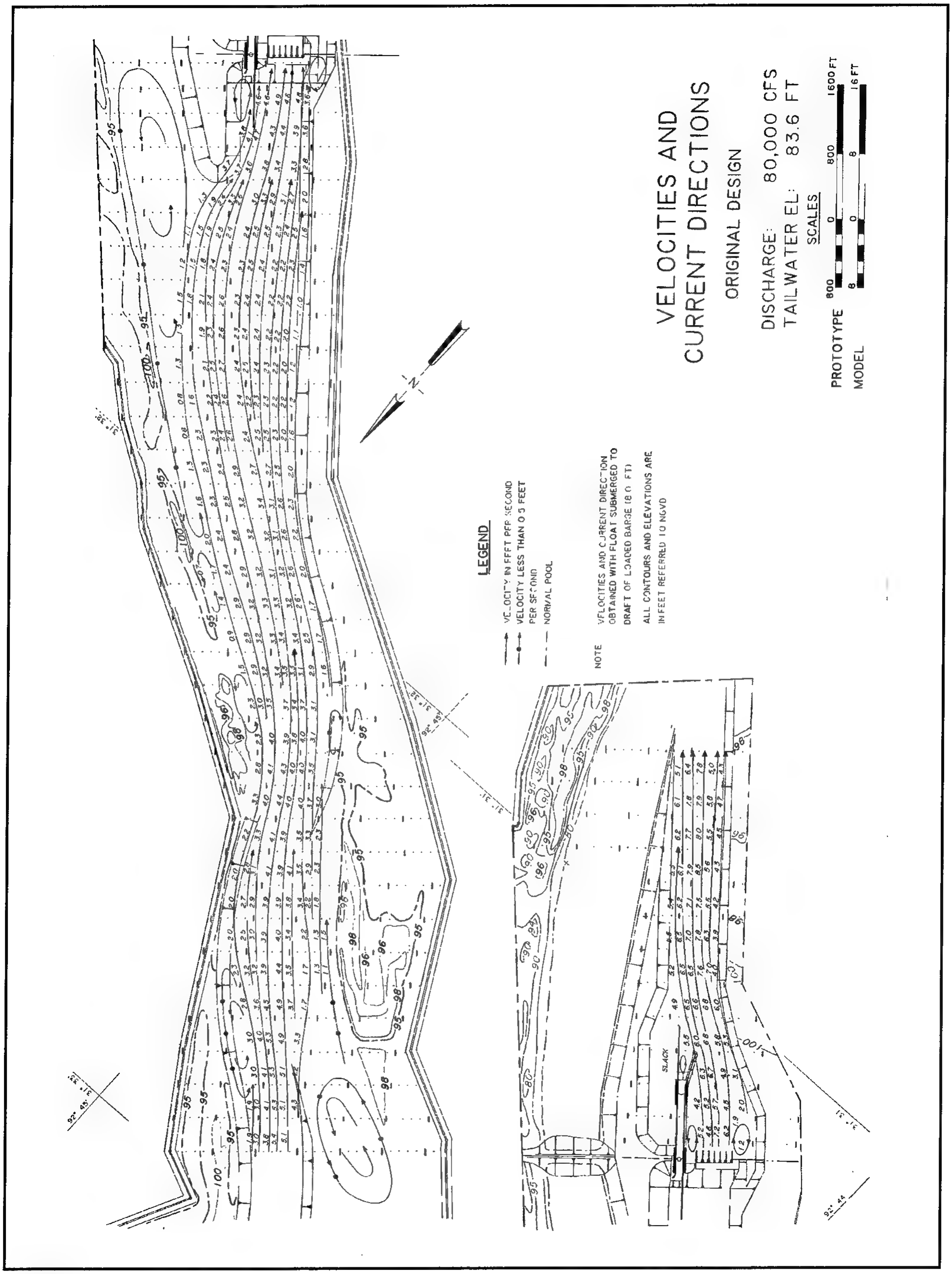
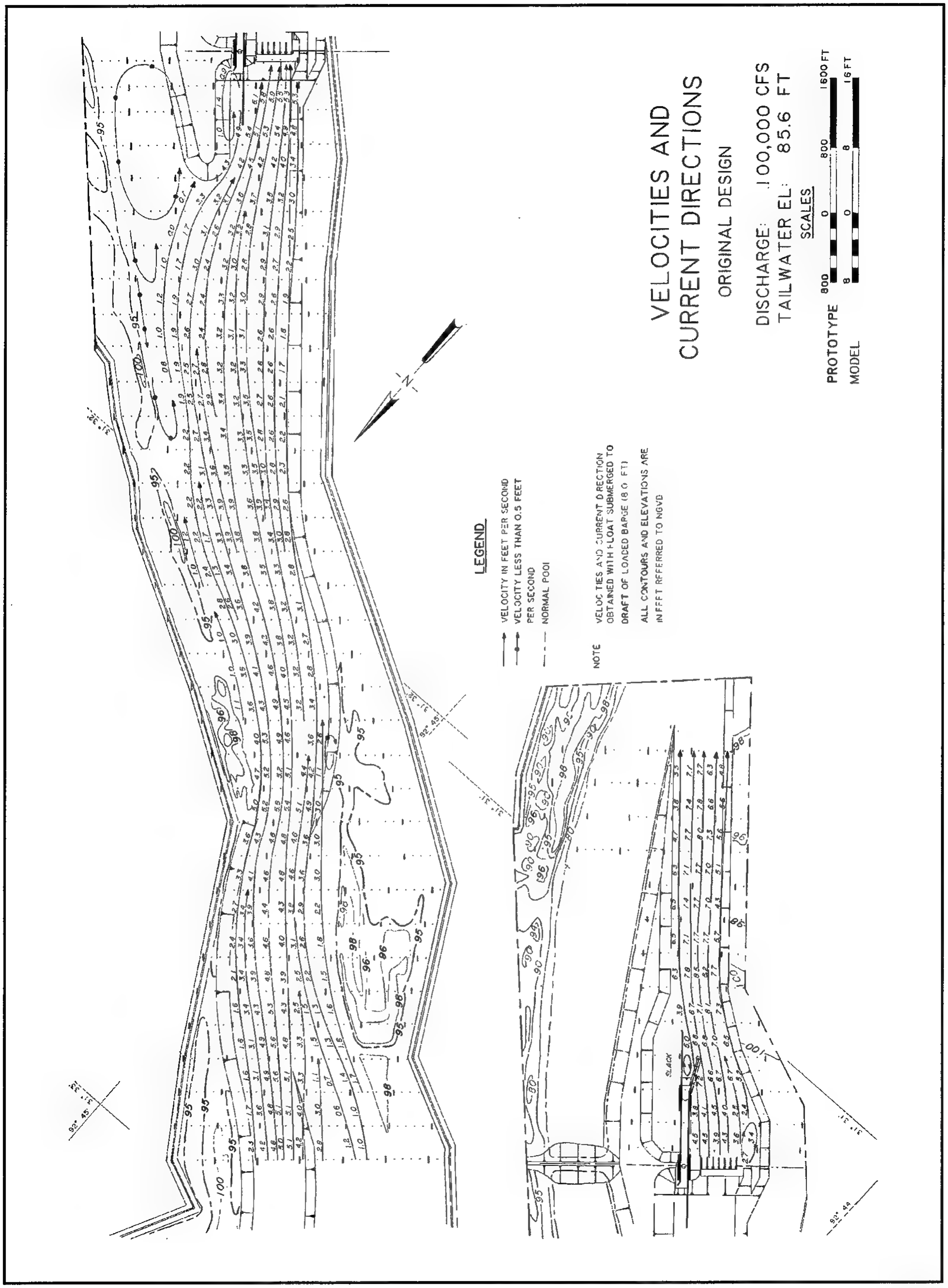

VELOCITIES AND CURRENT DIRECTIONS
ORIGINAL DESIGN
DISCHARGE: 80,000 CFS
TAILWATER EL: 83.6 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE
VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SLACK

Plate 2



VELOCITIES AND
CURRENT DIRECTIONS
ORIGINAL DESIGN
DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE
VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SLACK
N

Plate 3

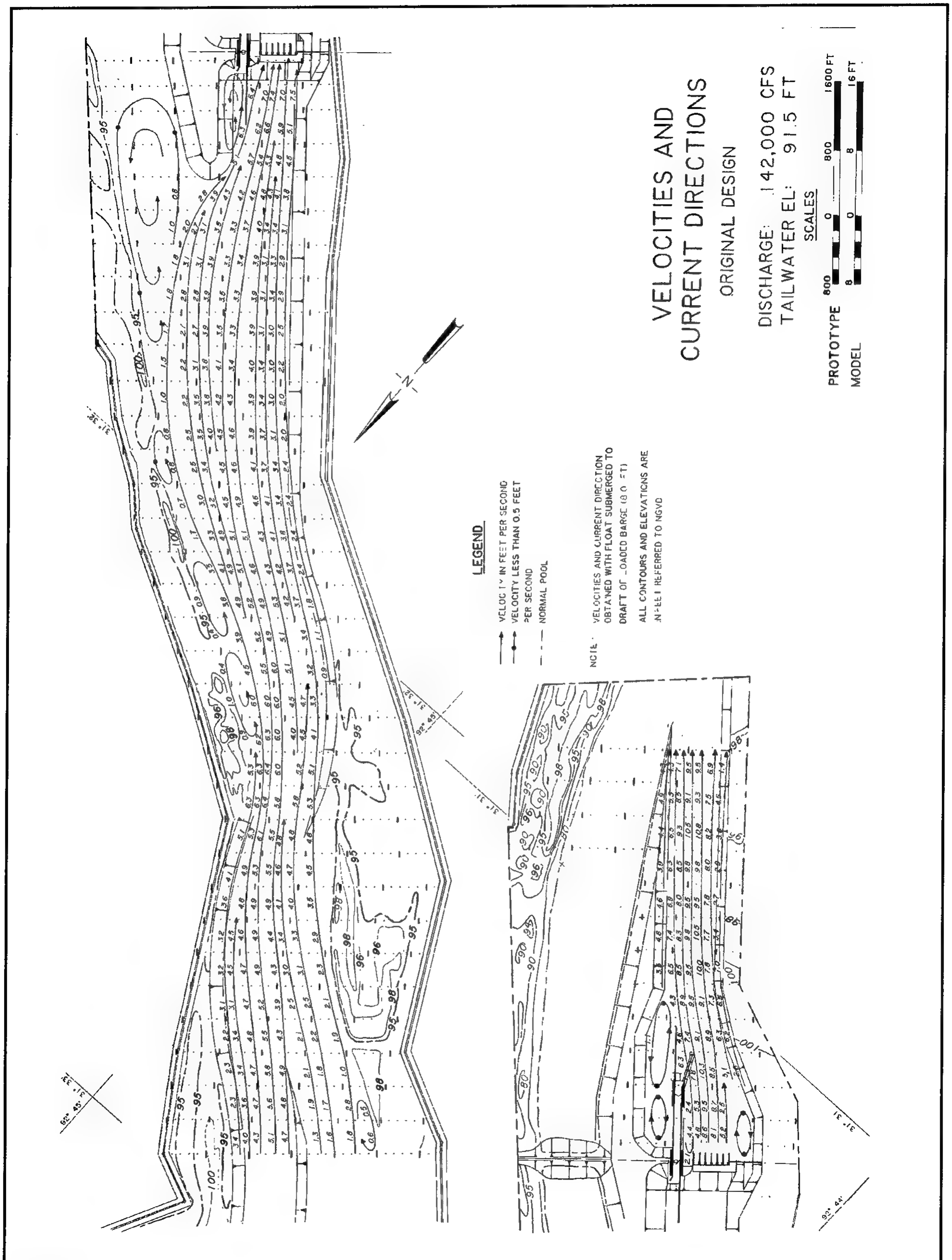
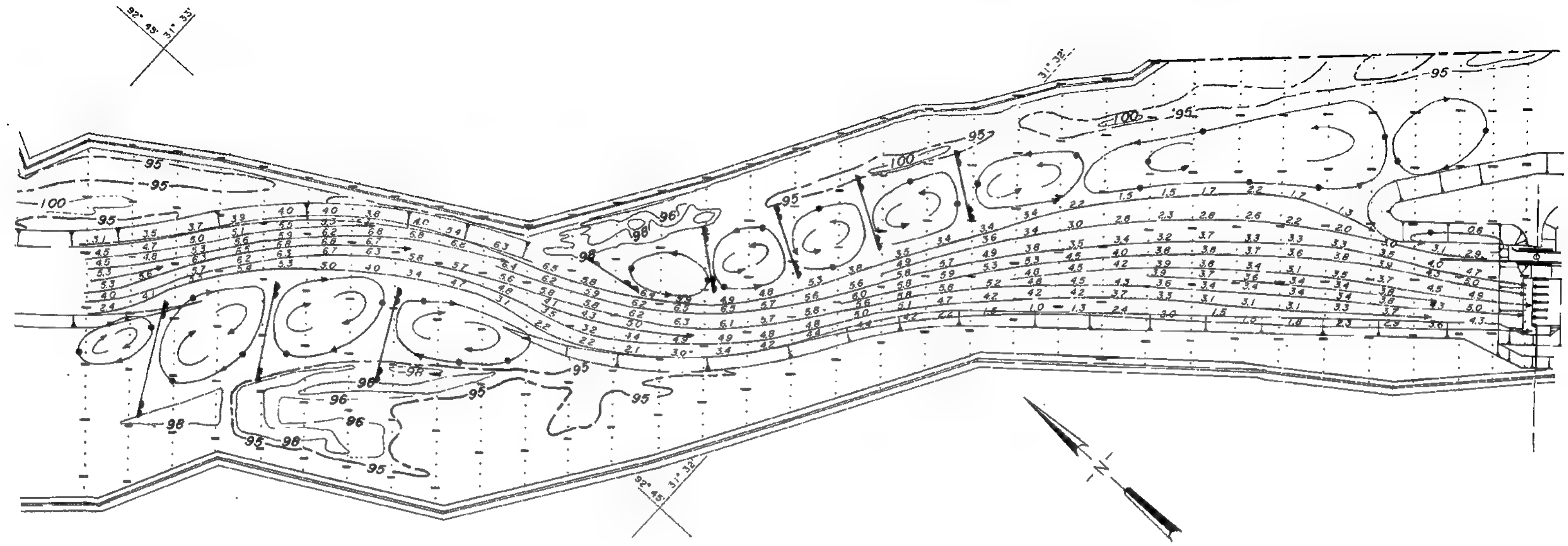

VELOCITIES AND
CURRENT DIRECTIONS
ORIGINAL DESIGN
DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

Plate 4



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN A

DISCHARGE: 80,000 CFS

TAILWATER EL: 94.1 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT

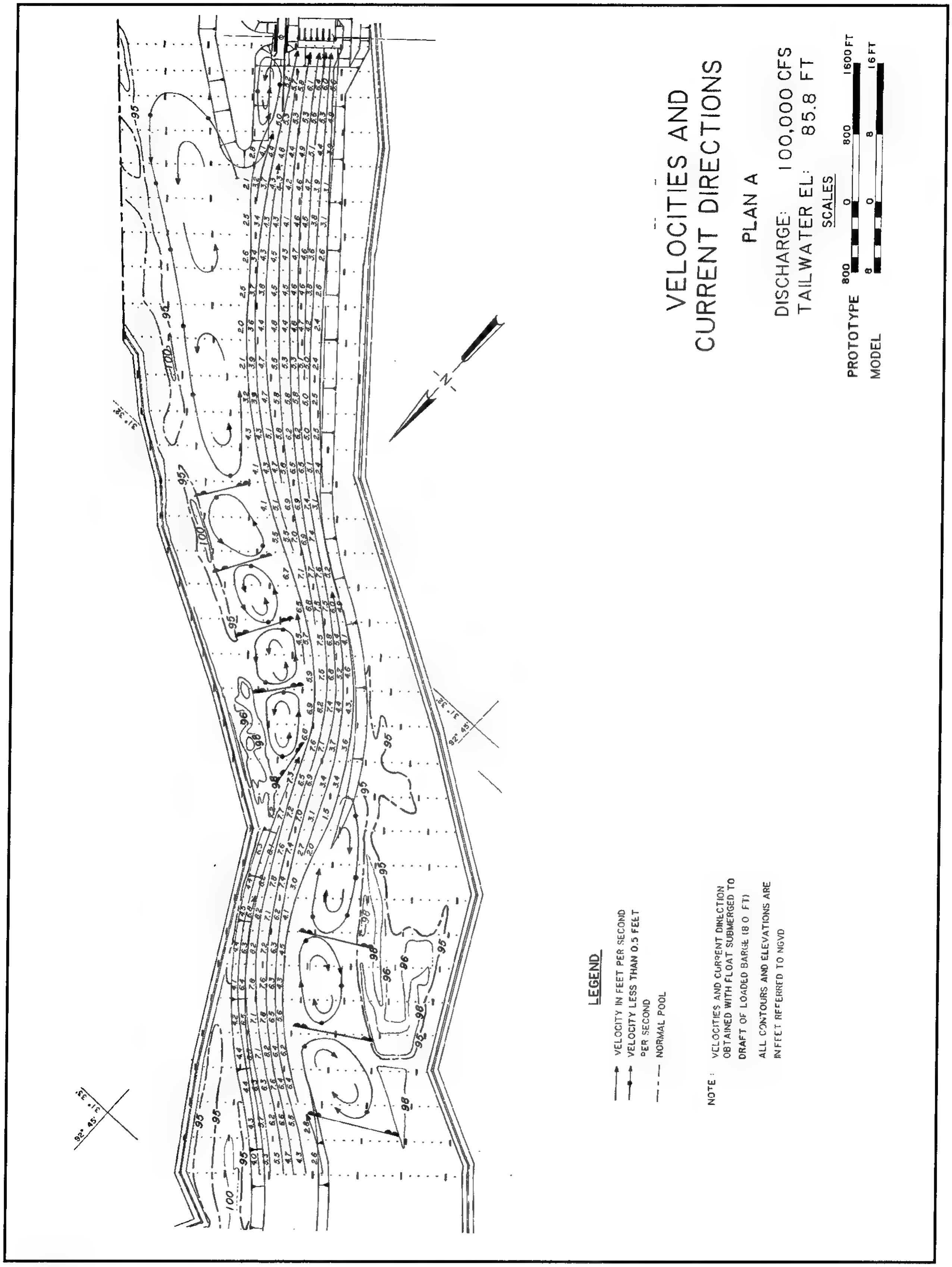
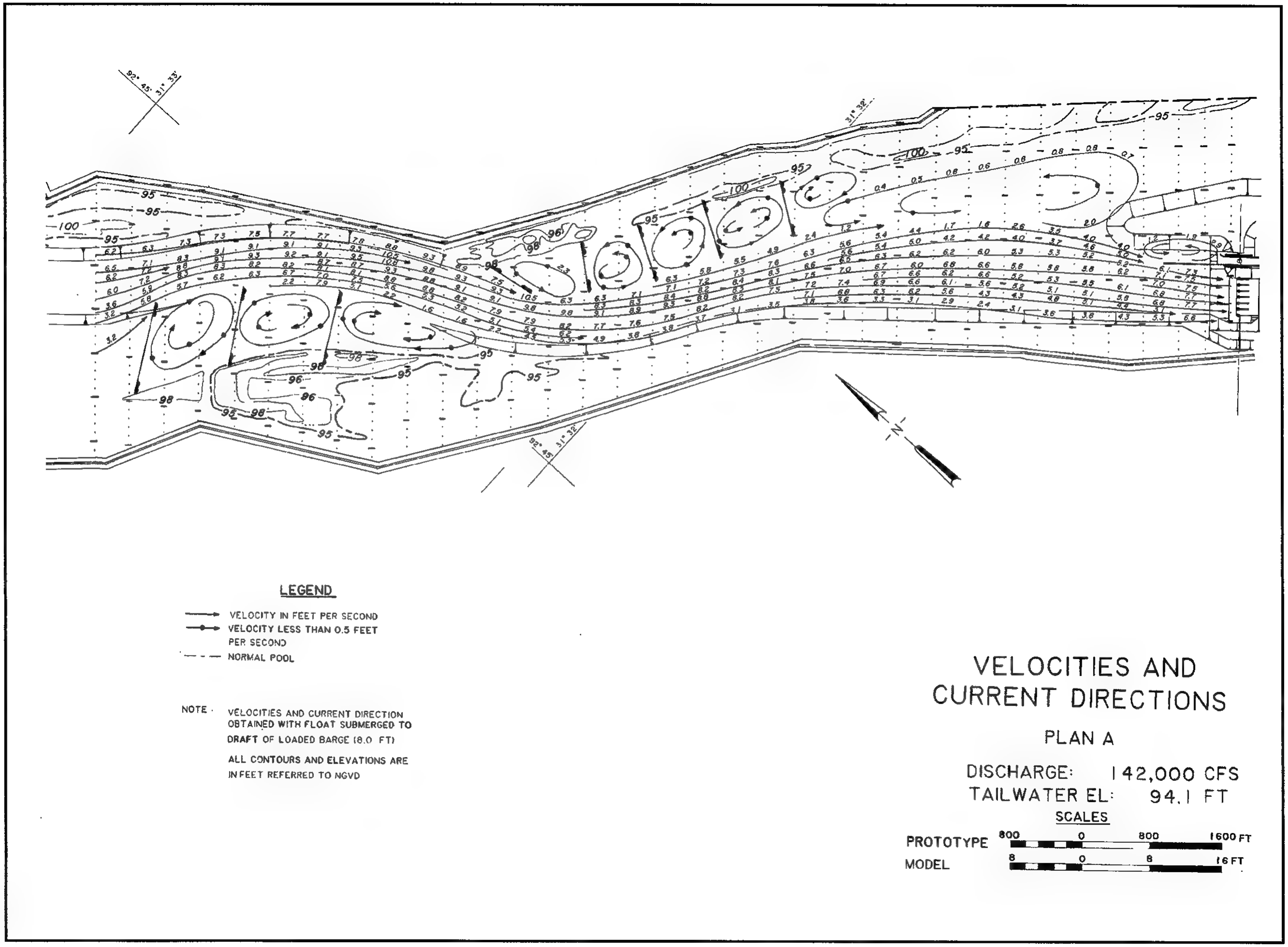

VELOCITIES AND CURRENT DIRECTIONS
PLAN A
DISCHARGE: 100,000 CFS
TAILWATER EL: 85.8 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
92° 45'
31° 32'

Plate 6


LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
VELOCITIES AND CURRENT DIRECTIONS
PLAN A
DISCHARGE: 142,000 CFS
TAILWATER EL: 94.1 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT

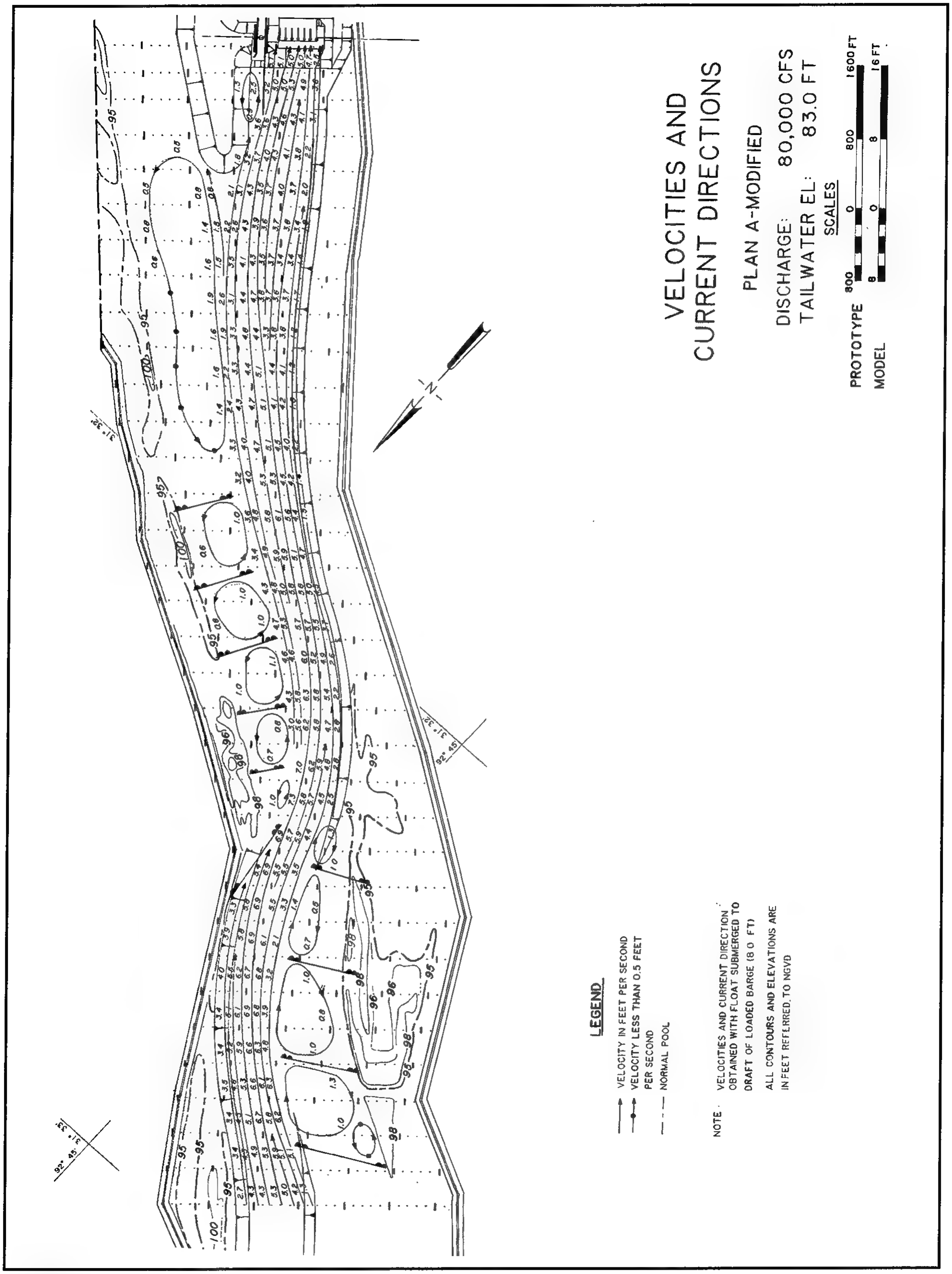
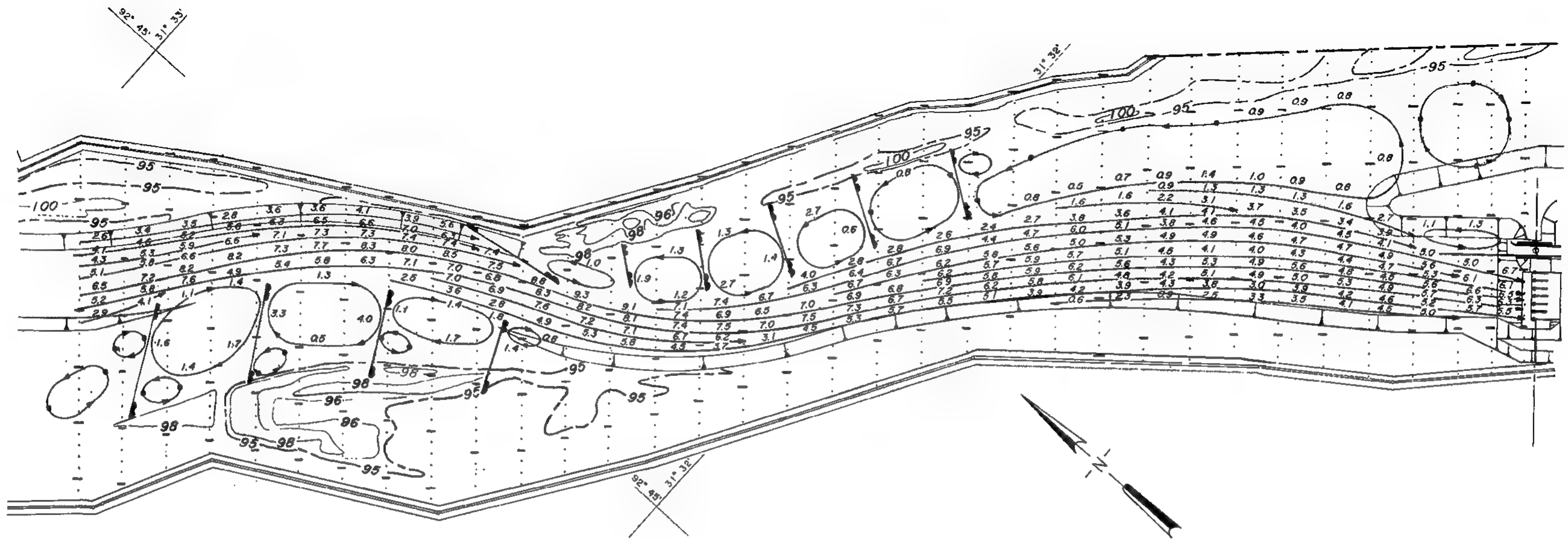

VELOCITIES AND CURRENT DIRECTIONS
PLAN A-MODIFIED
DISCHARGE: 80,000 CFS
TAILWATER EL: 83.0 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
N

Plate 8



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN A-MODIFIED

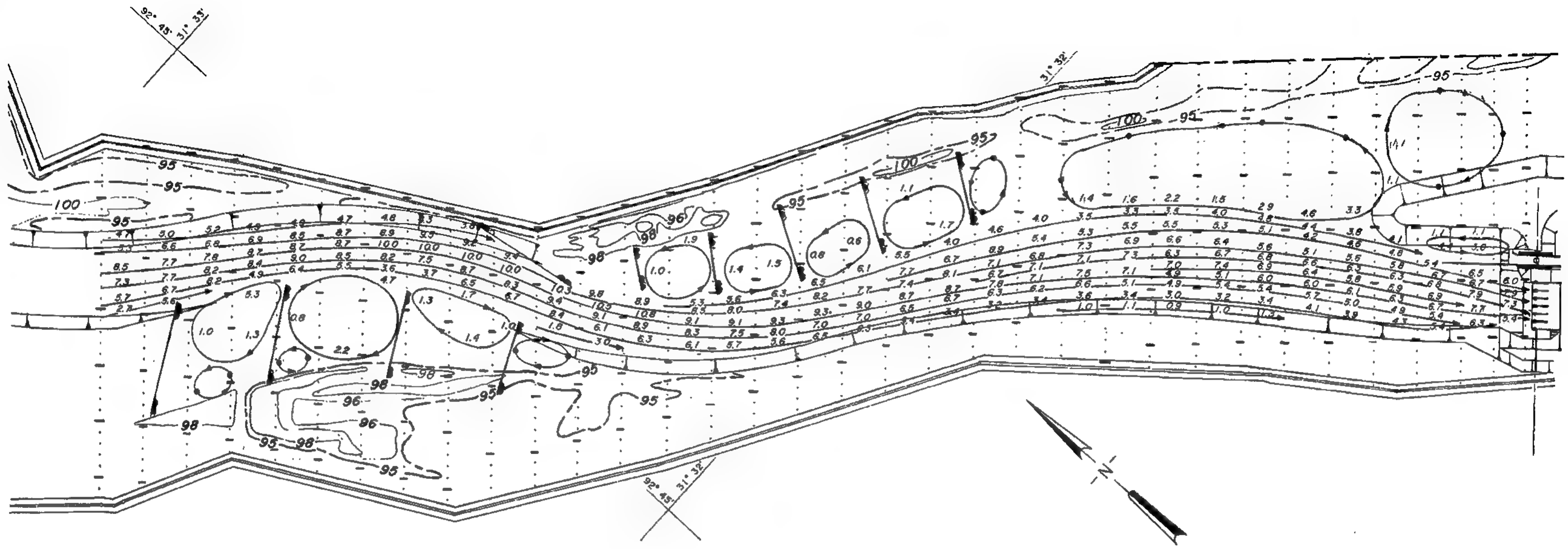
DISCHARGE: 100,000 CFS

TAILWATER EL: 85.6 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN A-MODIFIED

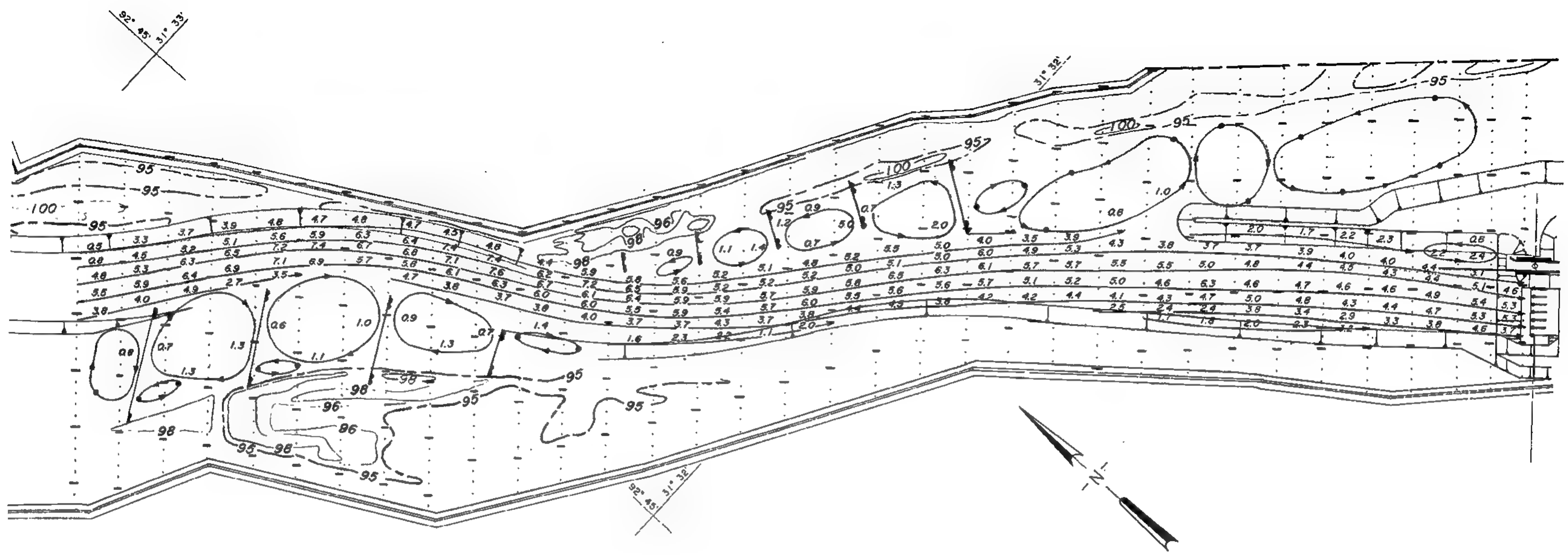
DISCHARGE: 142,000 CFS

TAILWATER EL: 91.5 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT



LEGEND

VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN B

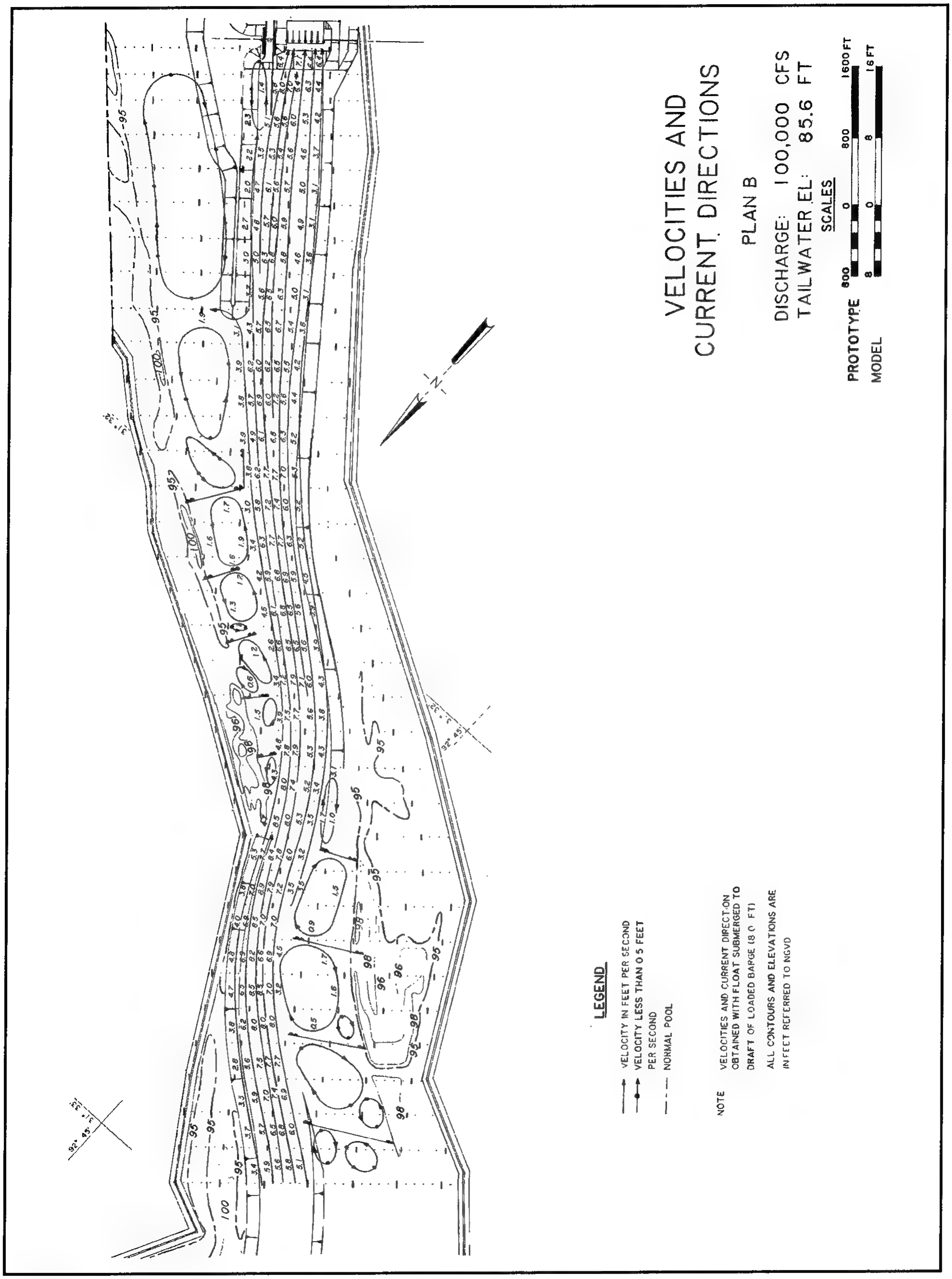
DISCHARGE: 80,000 CFS

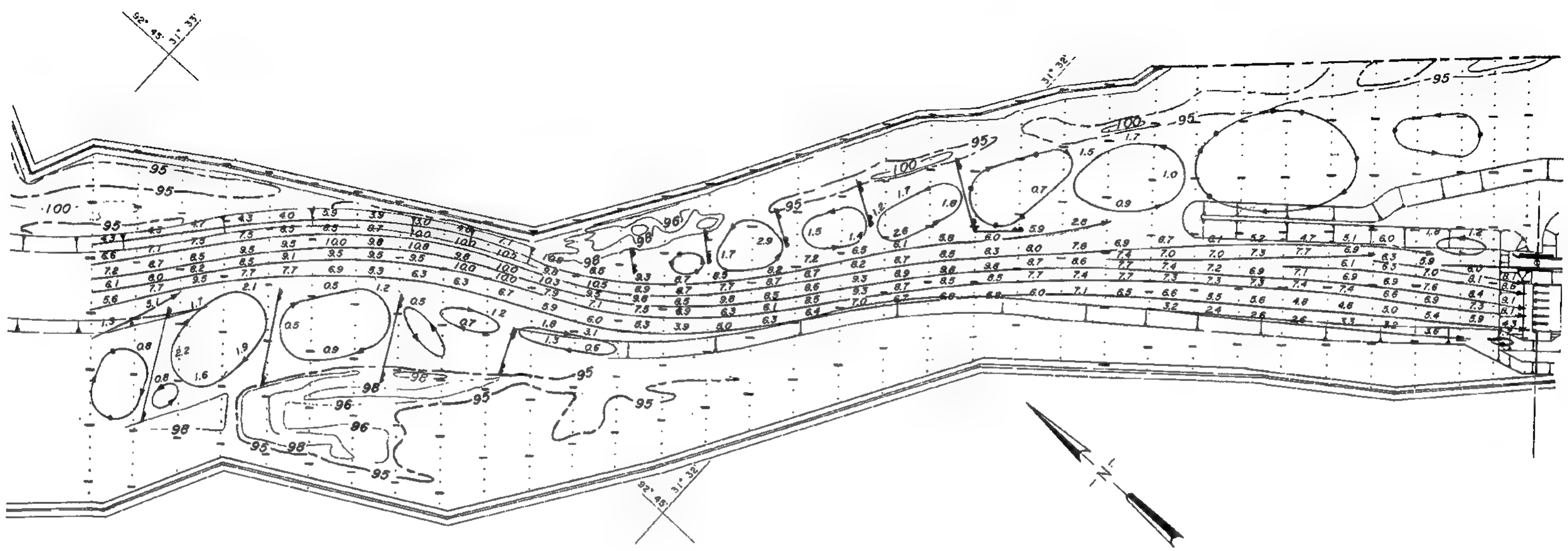
TAILWATER EL: 83.0 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT


VELOCITIES AND CURRENT DIRECTIONS
PLAN B
DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE
VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD



LEGEND

- → VELOCITY IN FEET PER SECOND
- →•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- — · — NORMAL POOL

NOTE : VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

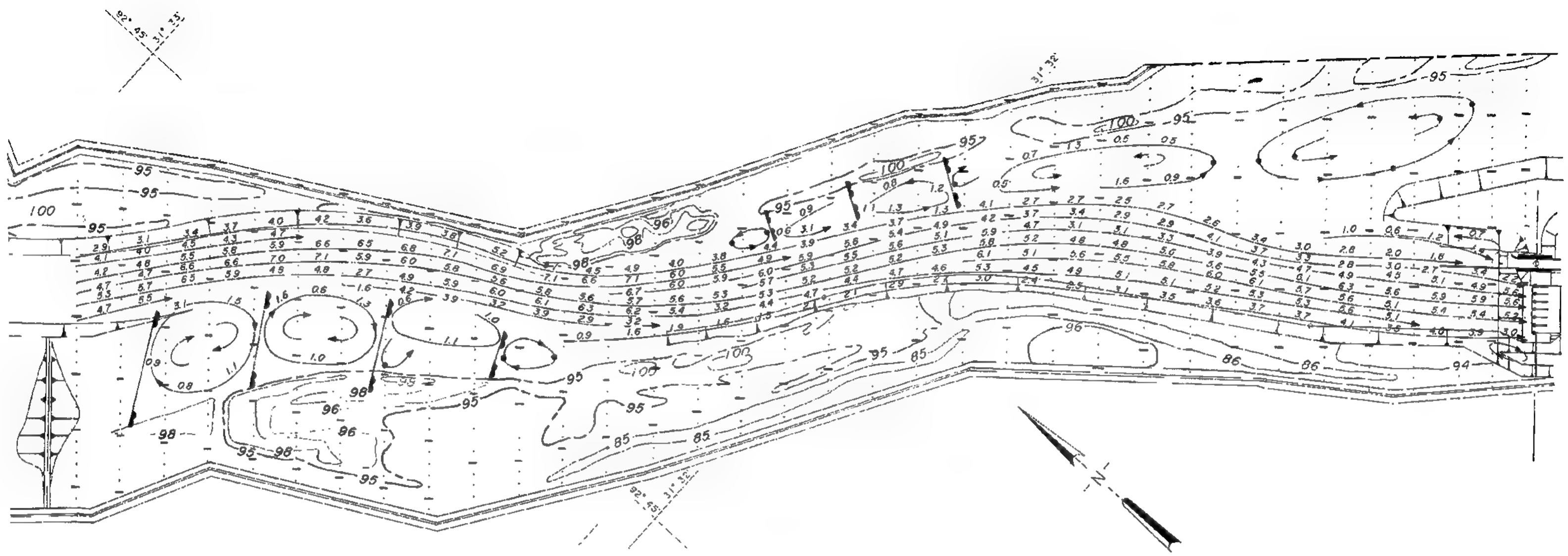
VELOCITIES AND CURRENT DIRECTIONS

PLAN B

DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT

SCALES

PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND
CURRENT DIRECTIONS

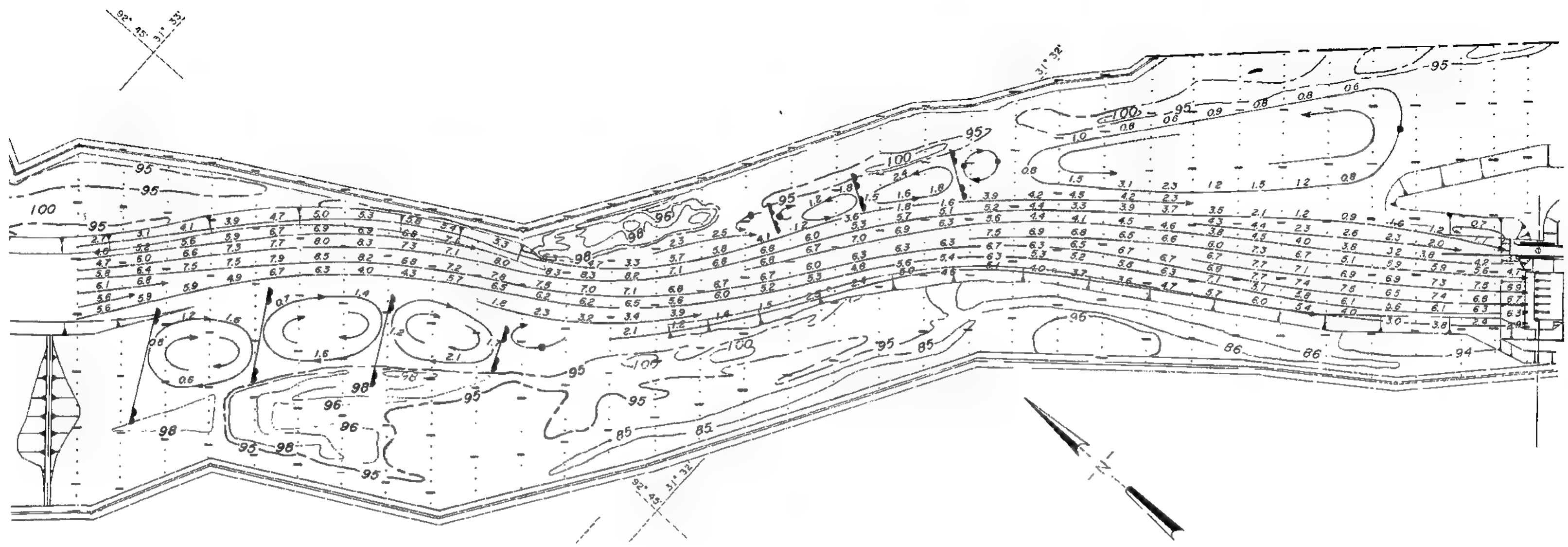
PLAN C

DISCHARGE: 80,000 CFS
TAILWATER EL: 83.0 FT

SCALES

PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT

Plate 14



LEGEND

- → VELOCITY IN FEET PER SECOND
- •→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- — — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

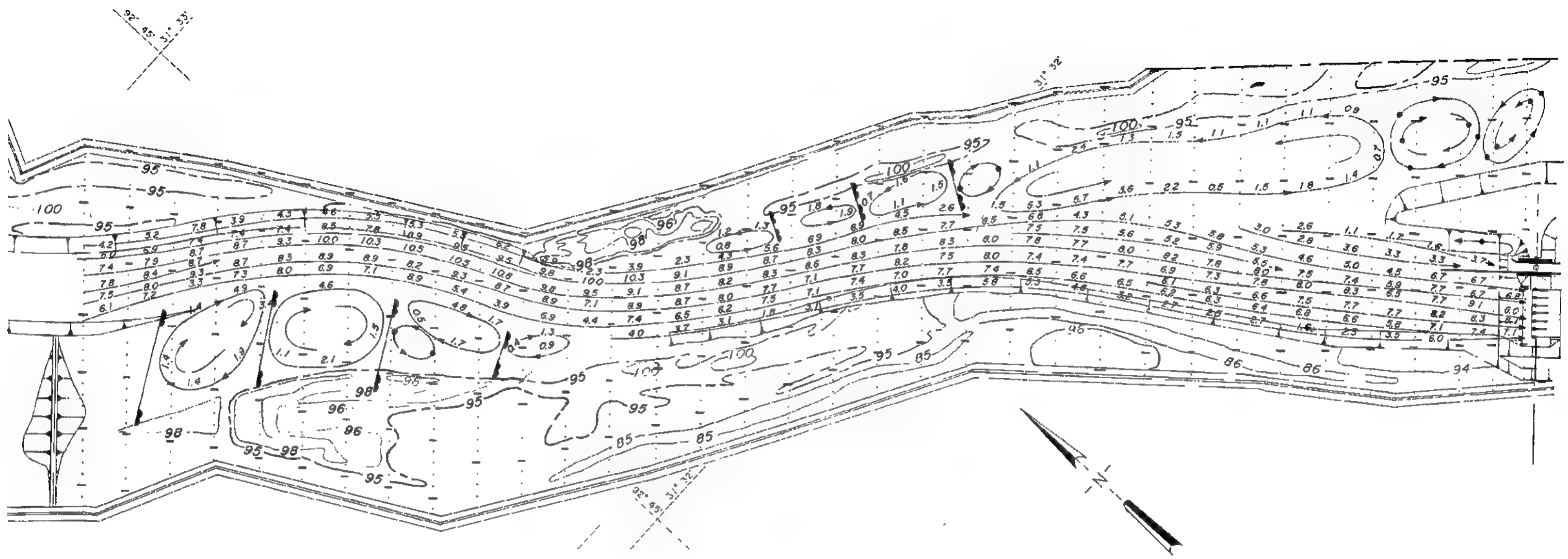
PLAN C

DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT

SCALES

PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT

Plate 15



LEGEND

VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN C

DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT

SCALES

PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT

Plate 16

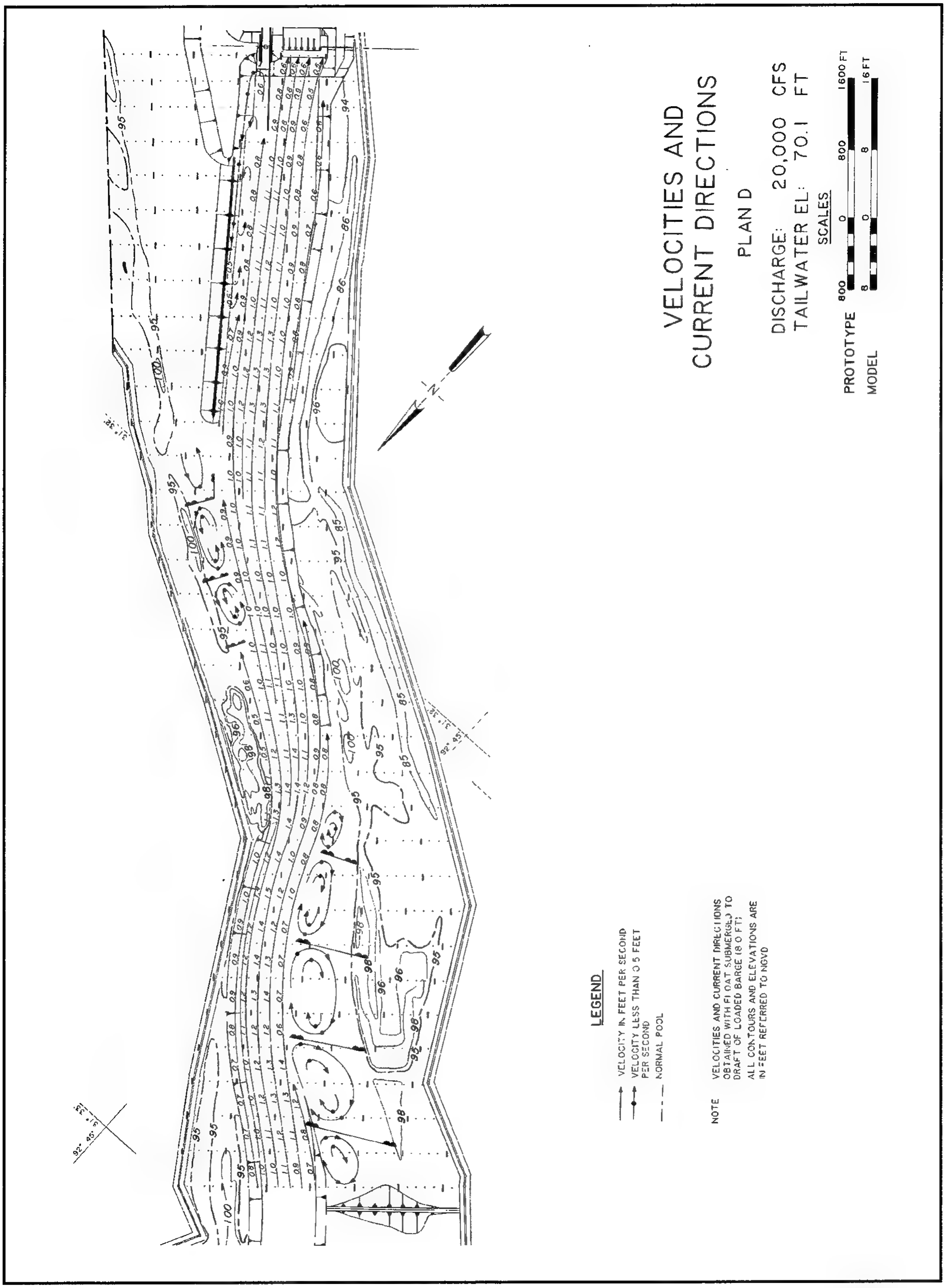
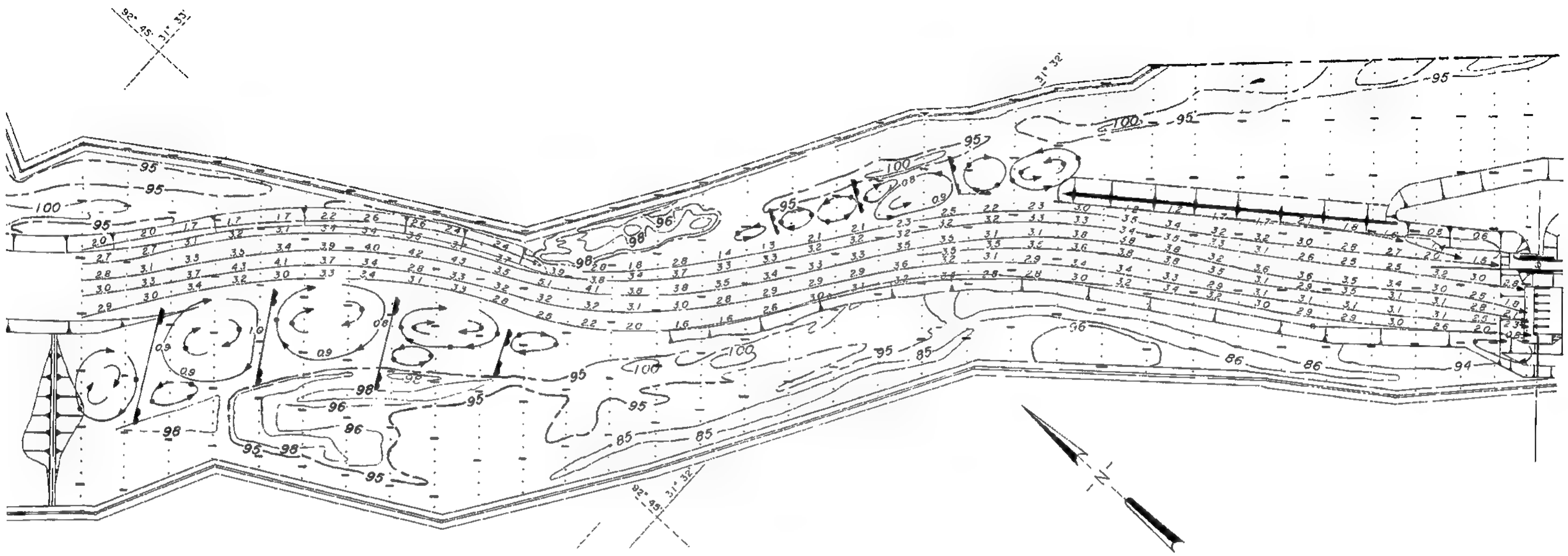

VELOCITIES AND
CURRENT DIRECTIONS
PLAN D
DISCHARGE: 20,000 CFS
TAILWATER EL: 70.1 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT); ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
N

Plate 17



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT. DIRECTIONS

PLAN D

DISCHARGE: 60,000 CFS

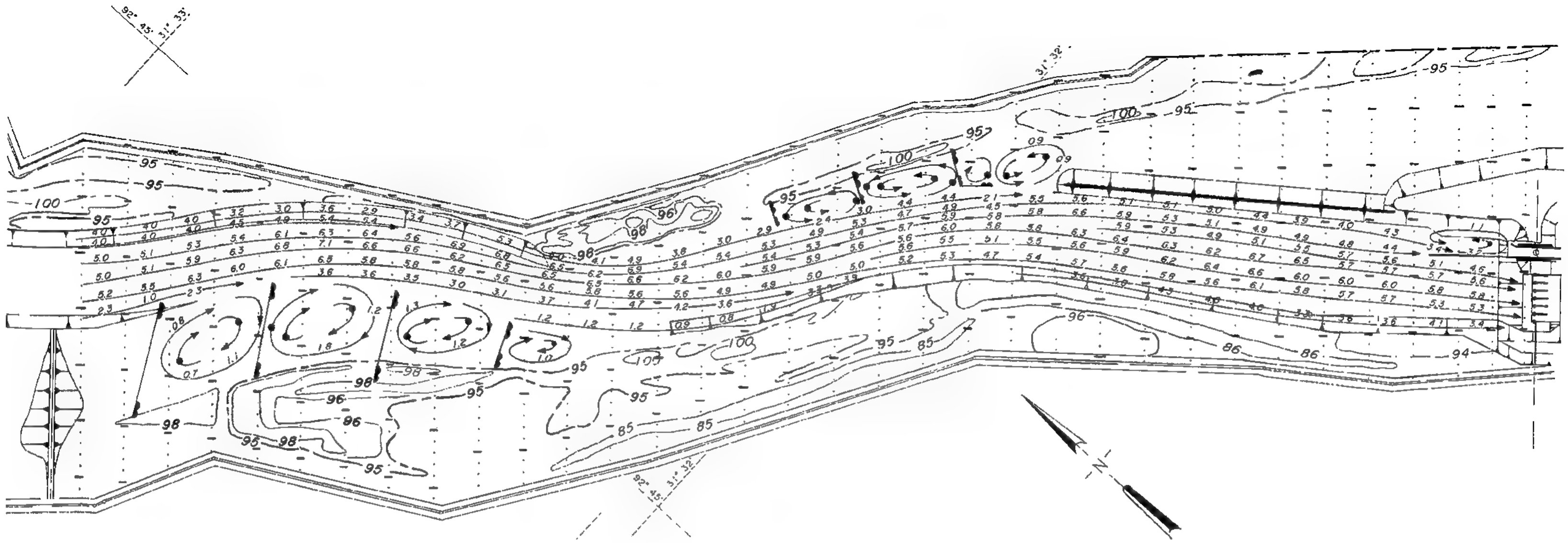
TAILWATER EL: 79.8 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT

Plate 18



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN D

DISCHARGE: 80,000 CFS

TAILWATER EL: 83.0 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT

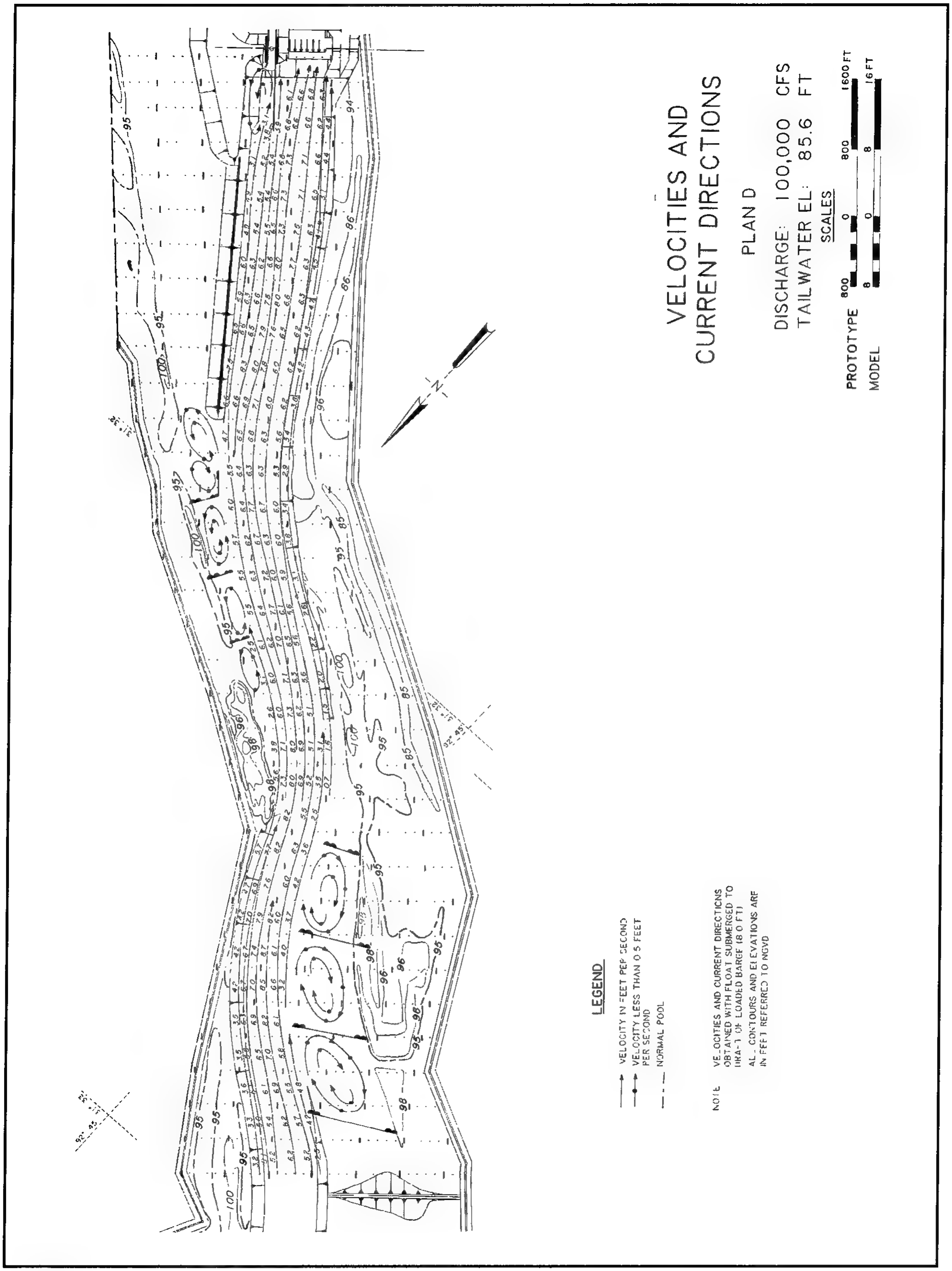
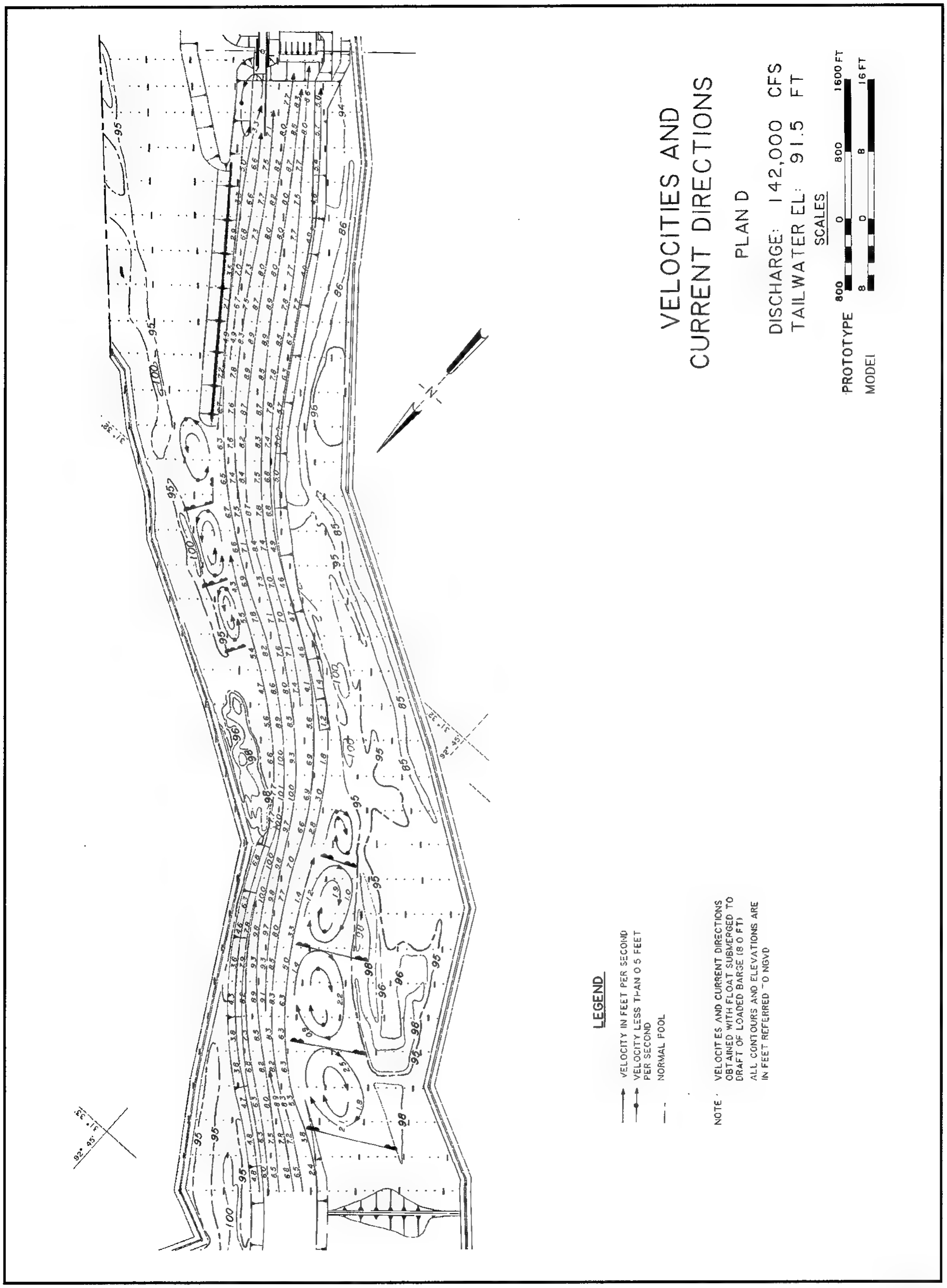
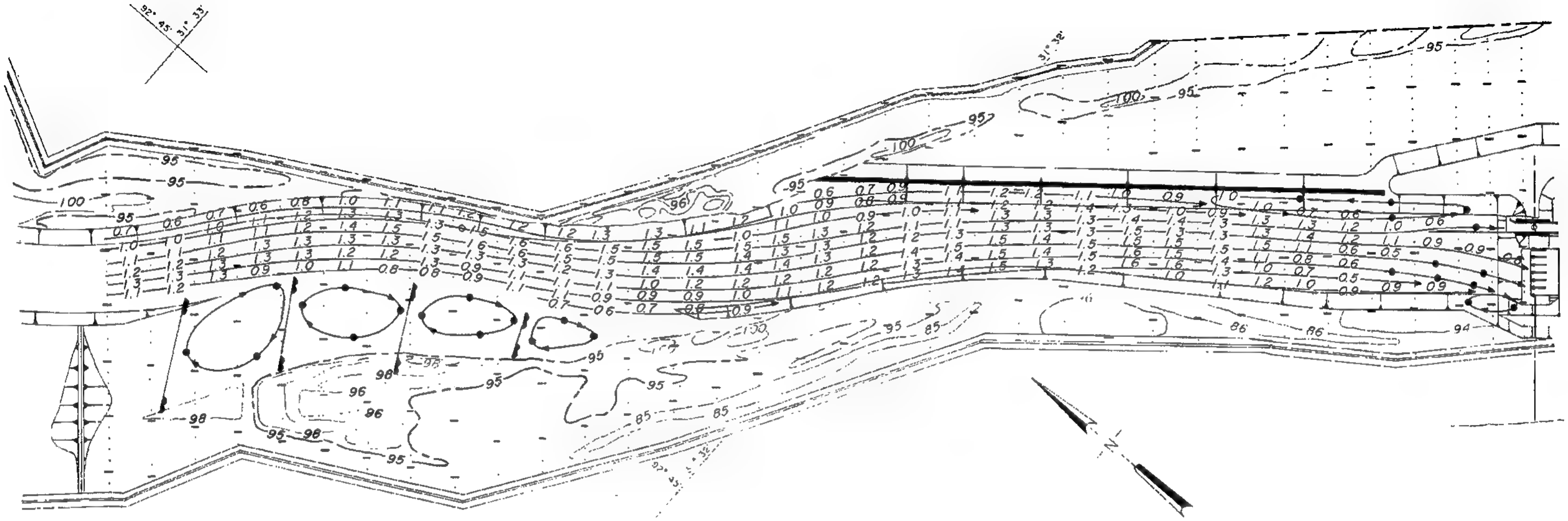

VELOCITIES AND CURRENT DIRECTIONS
PLAN D
DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

Plate 20


VELOCITIES AND
CURRENT DIRECTIONS
PLAN D
DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD



LEGEND

VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN E

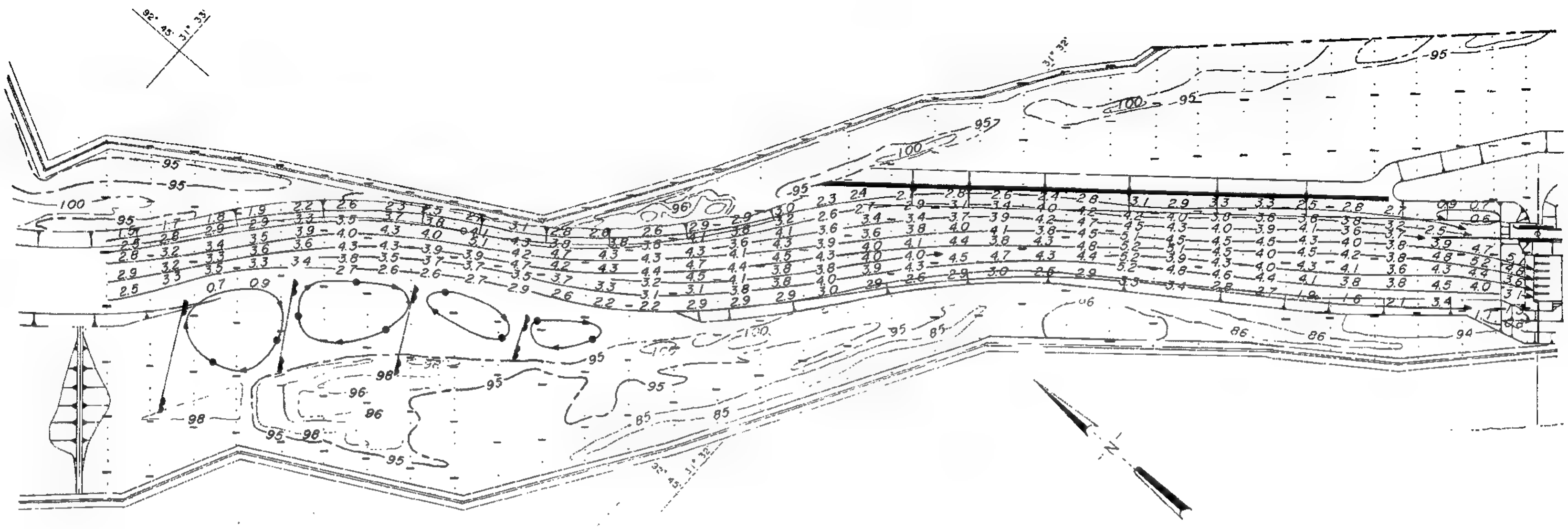
DISCHARGE: 20,000 CFS

UPPER POOL FL: 95.0 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN E

DISCHARGE: 60,000 CFS

UPPER POOL EL: 94.0 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT

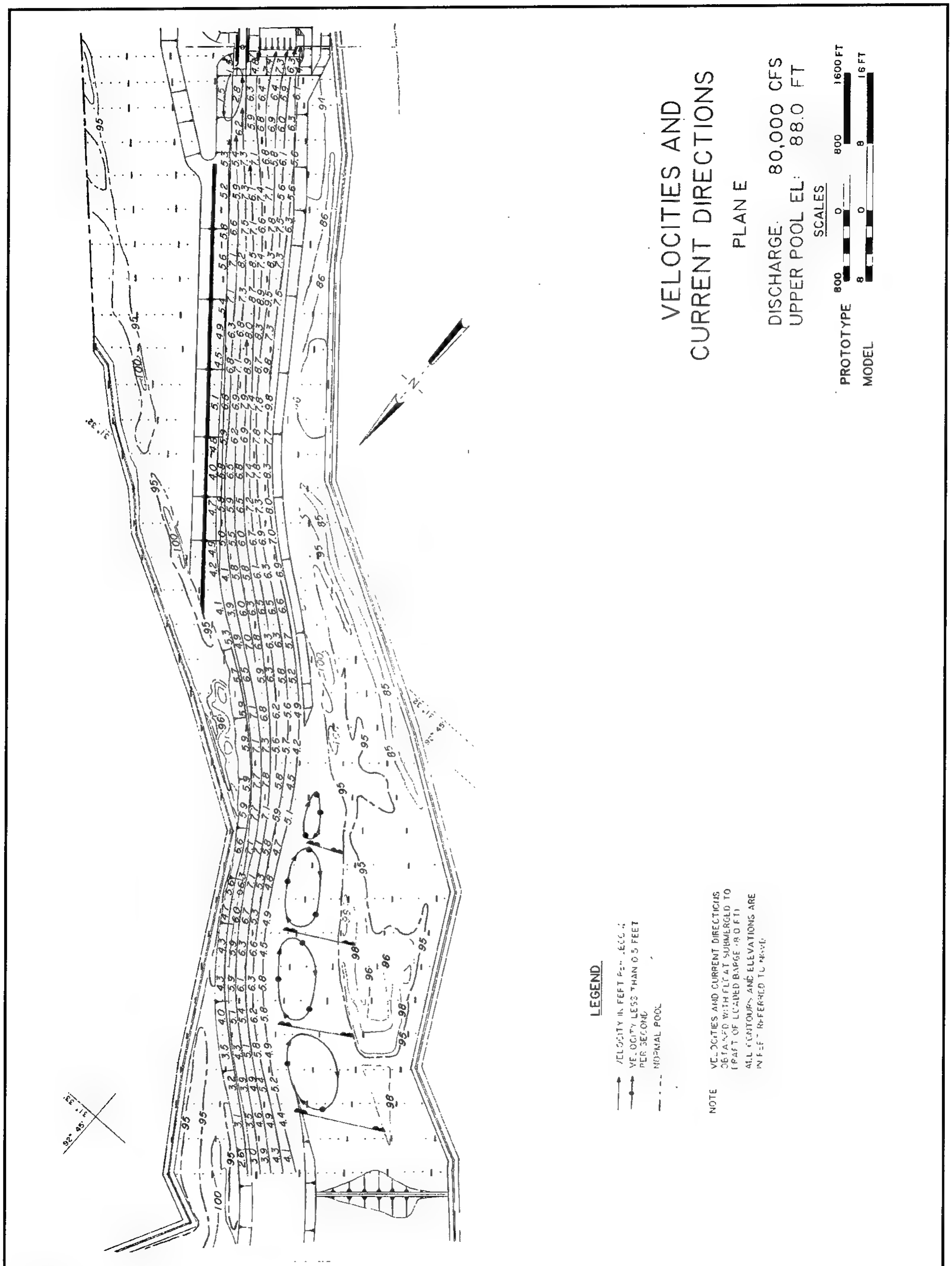
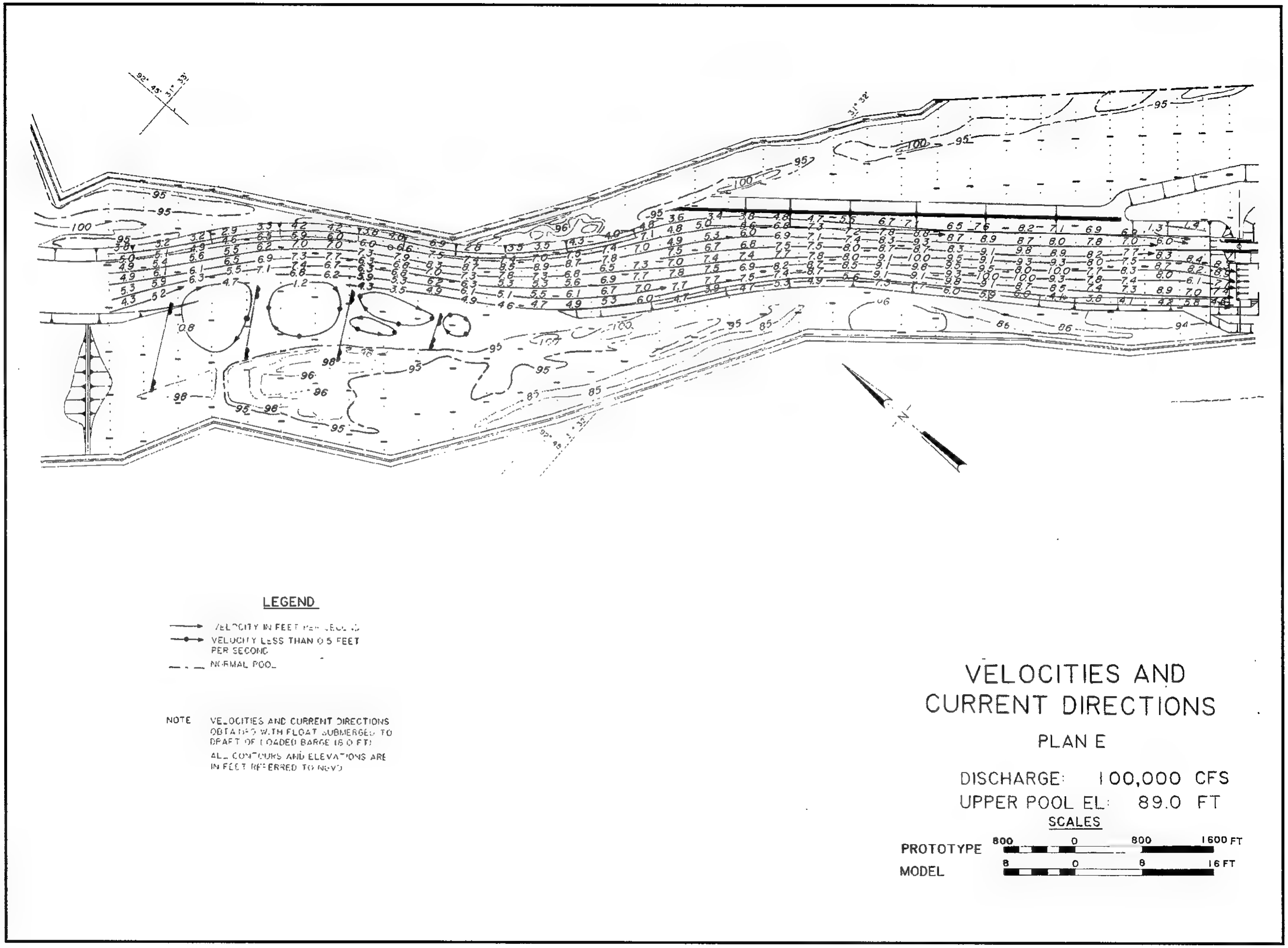

VELOCITIES AND CURRENT DIRECTIONS
PLAN E
DISCHARGE: 80,000 CFS
UPPER POOL EL: 88.0 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
NORMAL POOL
NOTE

Plate 24



LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
VELOCITIES AND CURRENT DIRECTIONS
PLAN E
DISCHARGE: 100,000 CFS
UPPER POOL EL: 89.0 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT

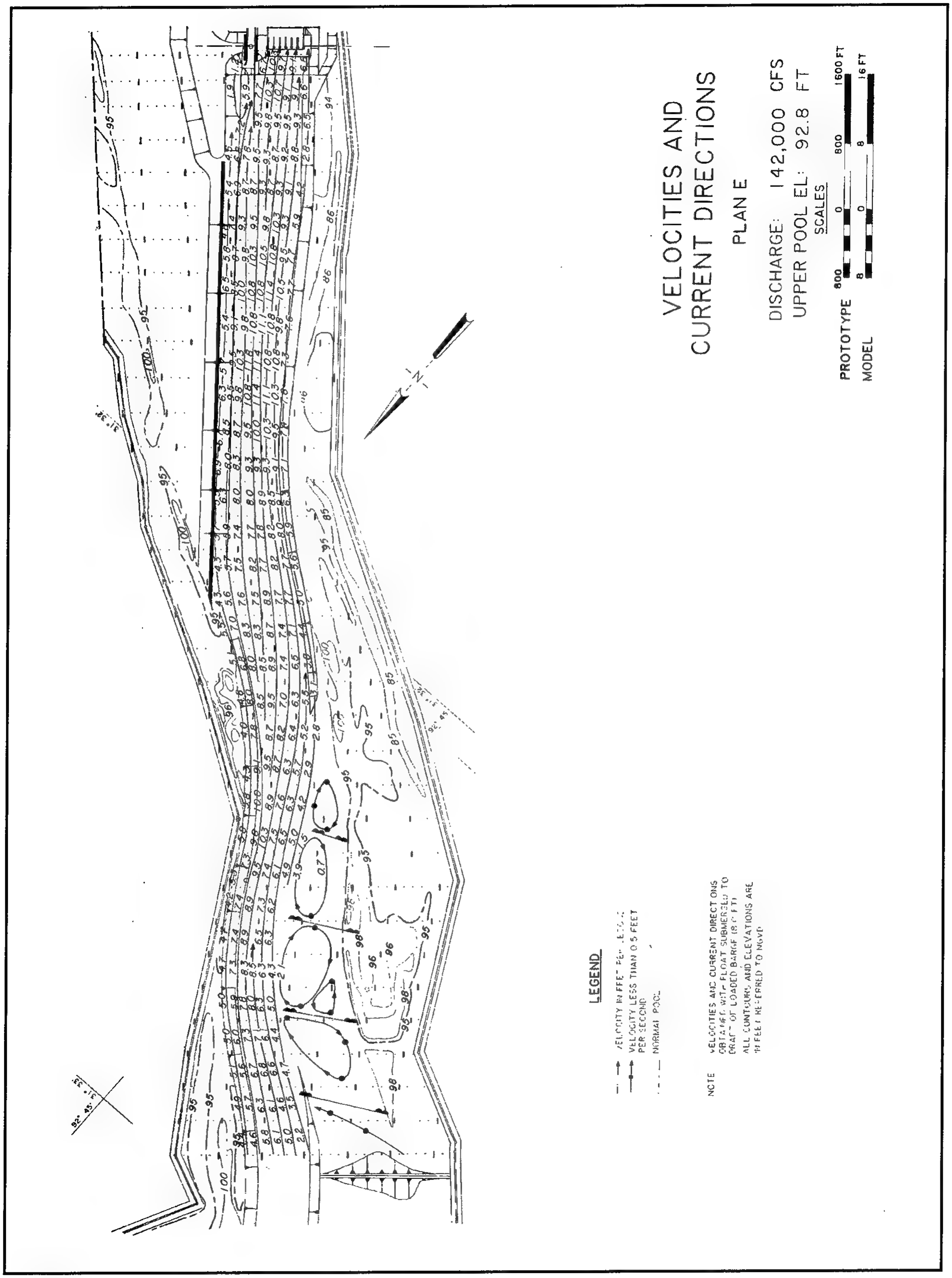
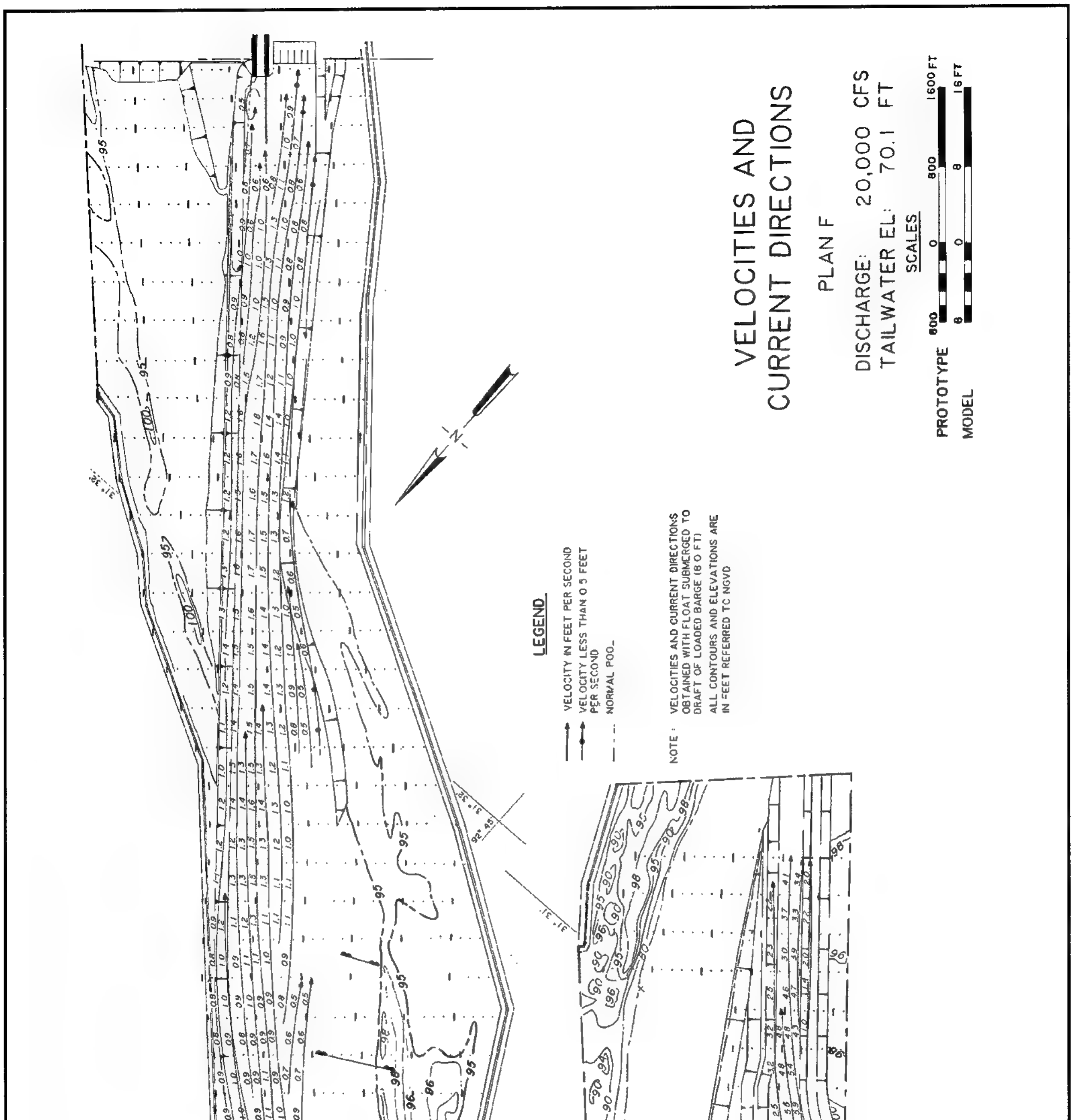

VELOCITIES AND
CURRENT DIRECTIONS
PLAN E
DISCHARGE: 142,000 CFS
UPPER POOL EL: 92.8 FT
SCALES
PROTOTYPE
MODEL
800 0 800 1600 FT
8 0 8 16 FT
LEGEND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE
ALL CONTOURS AND ELEVATIONS ARE

Plate 26


VELOCITIES AND CURRENT DIRECTIONS
PLAN F
DISCHARGE: 20,000 CFS
TAILWATER EL: 70.1 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
N

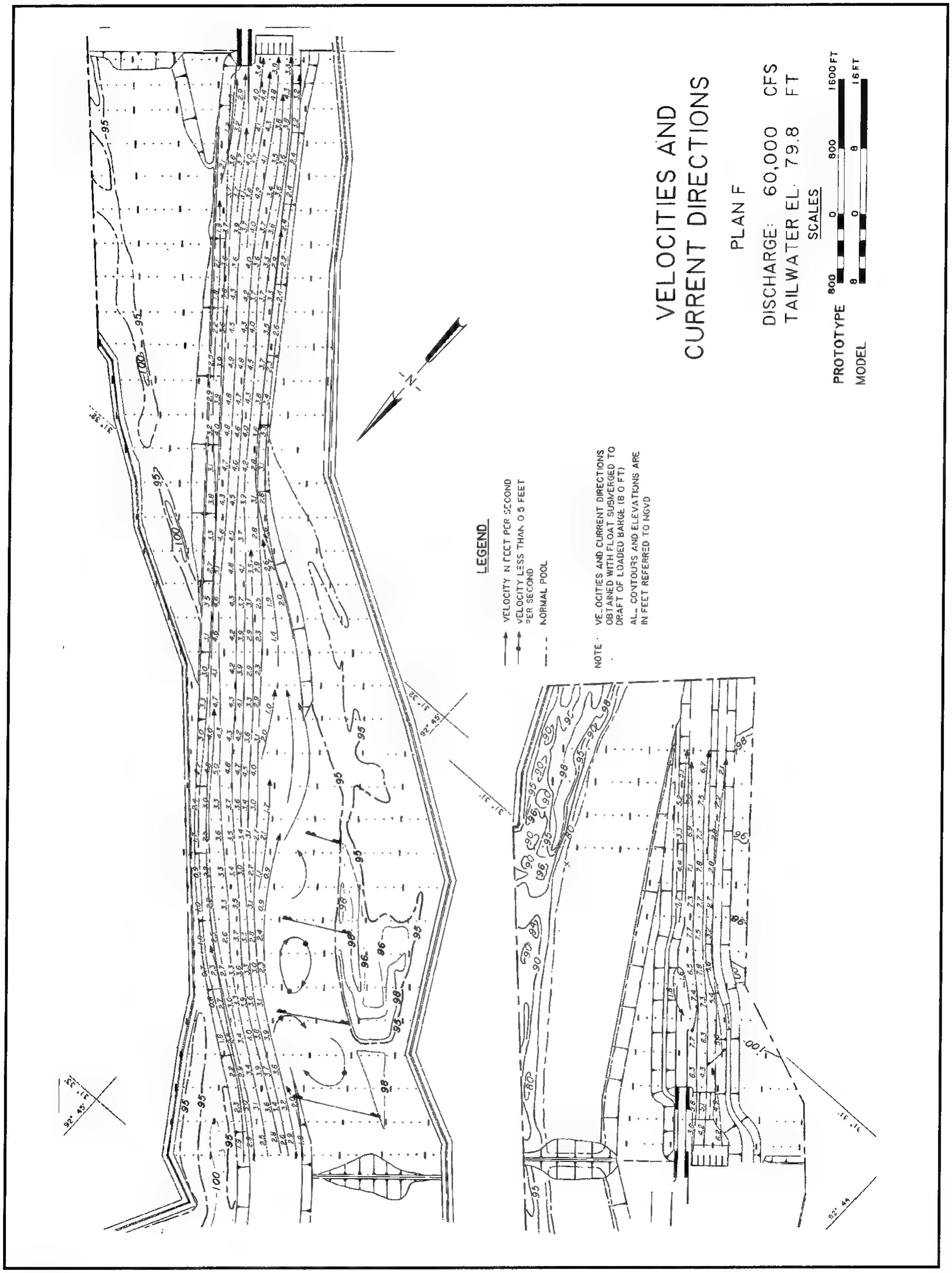
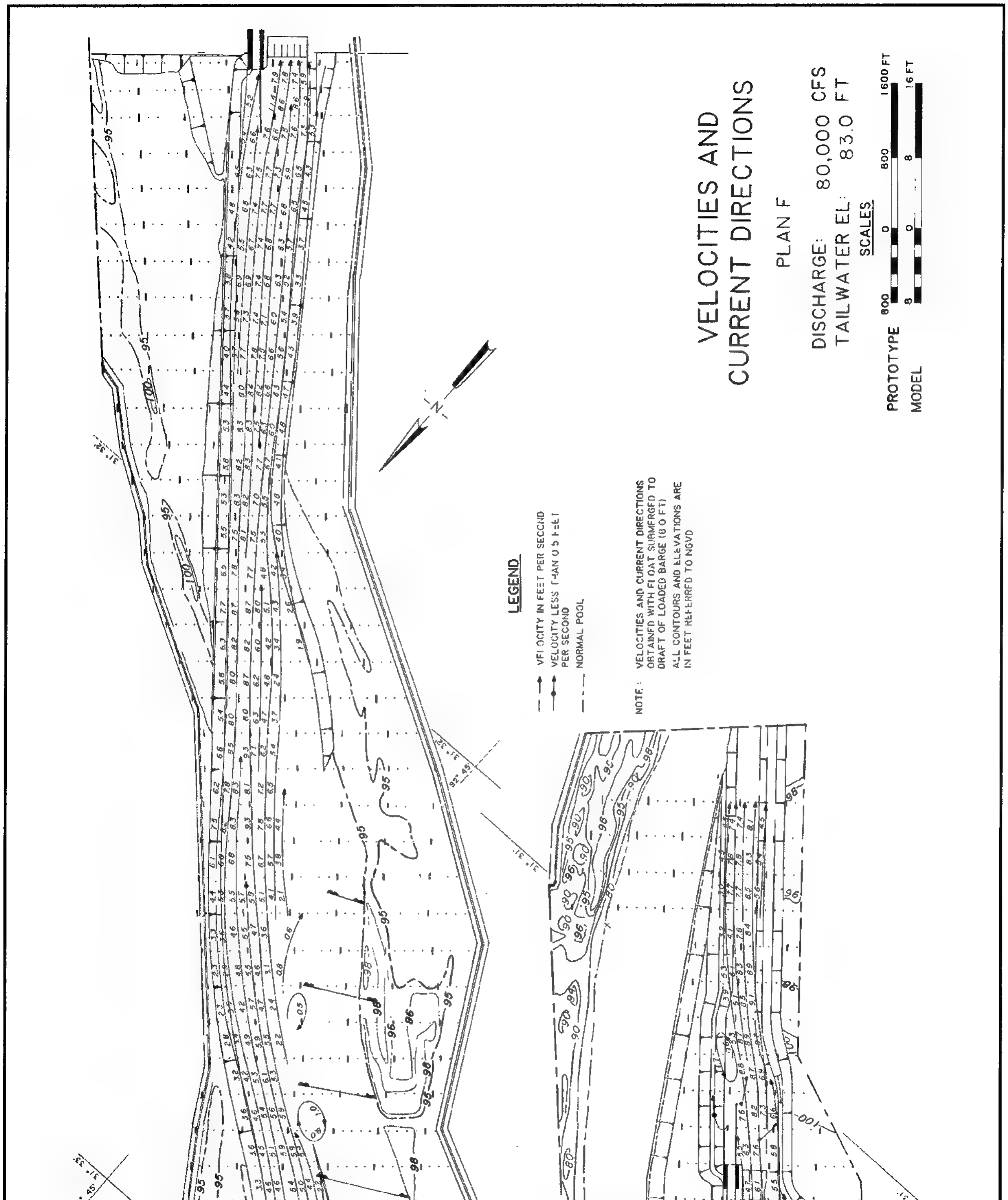

VELOCITIES AND CURRENT DIRECTIONS
PLAN F
DISCHARGE: 60,000 CFS
TAILWATER EL. 79.8 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

Plate 28


VELOCITIES AND CURRENT DIRECTIONS
PLAN F
DISCHARGE: 80,000 CFS
TAILWATER EL: 83.0 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

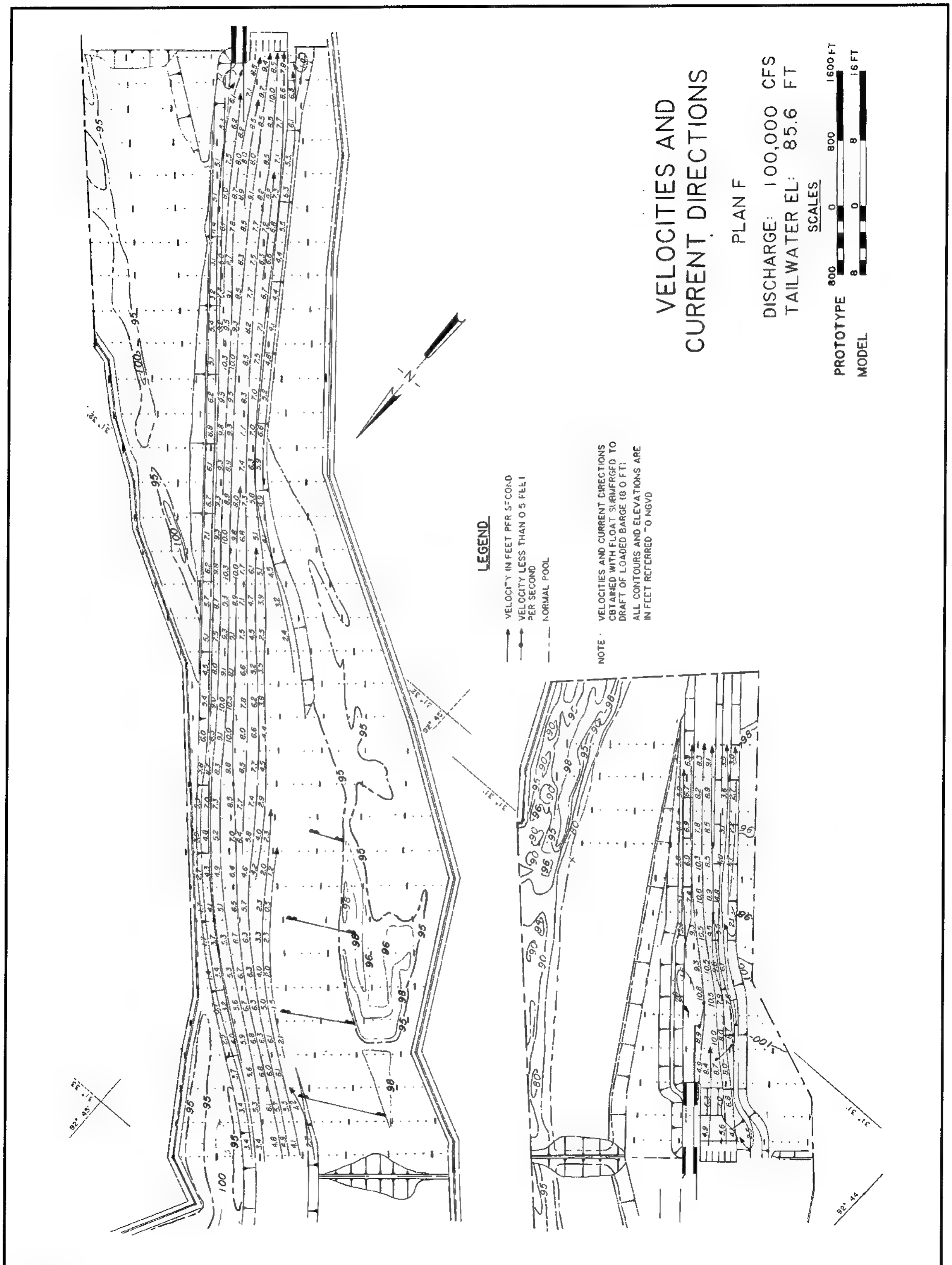
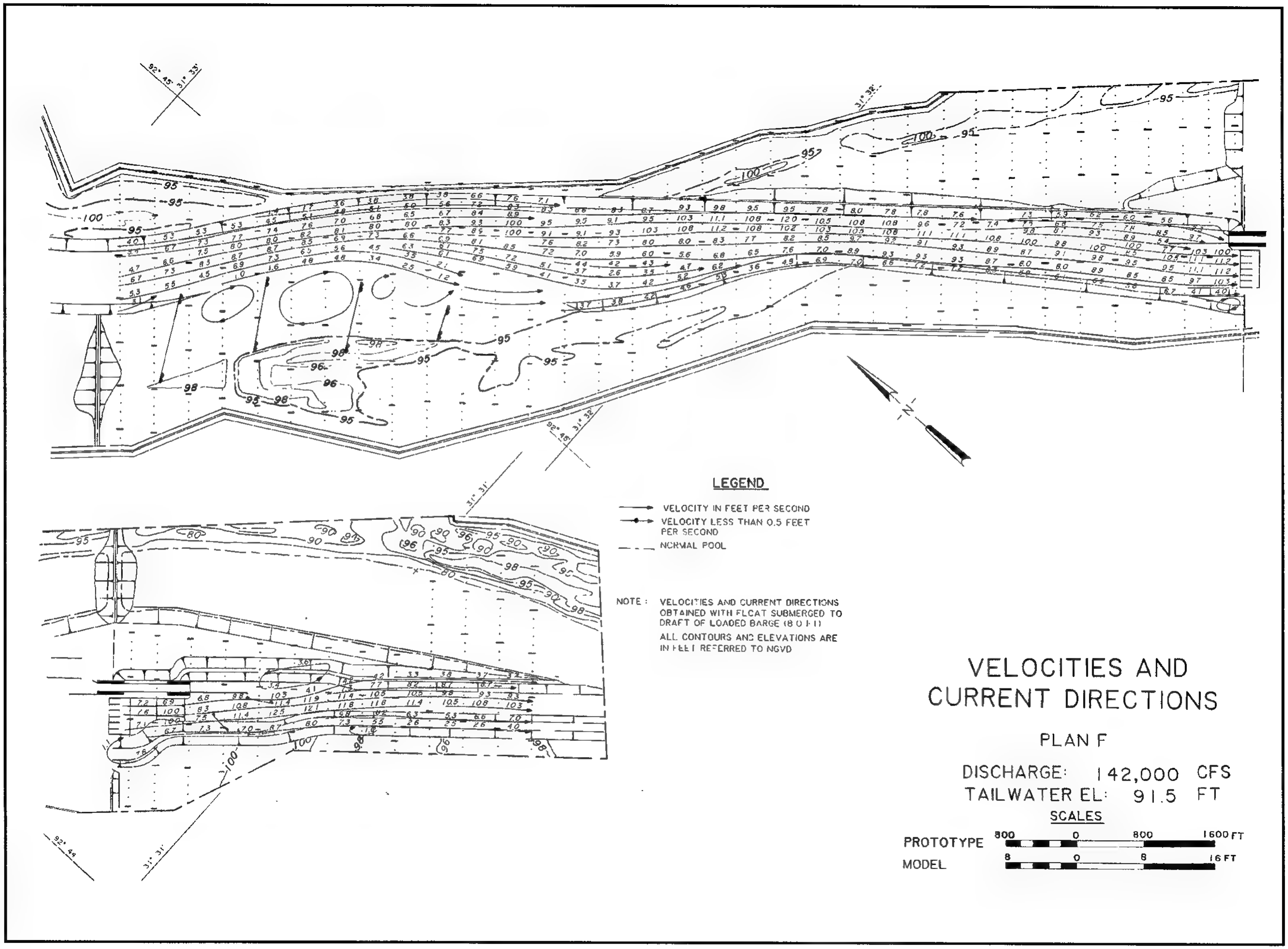

VELOCITIES AND CURRENT DIRECTIONS
PLAN F
DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

Plate 30


LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
VELOCITIES AND CURRENT DIRECTIONS
PLAN F
DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT

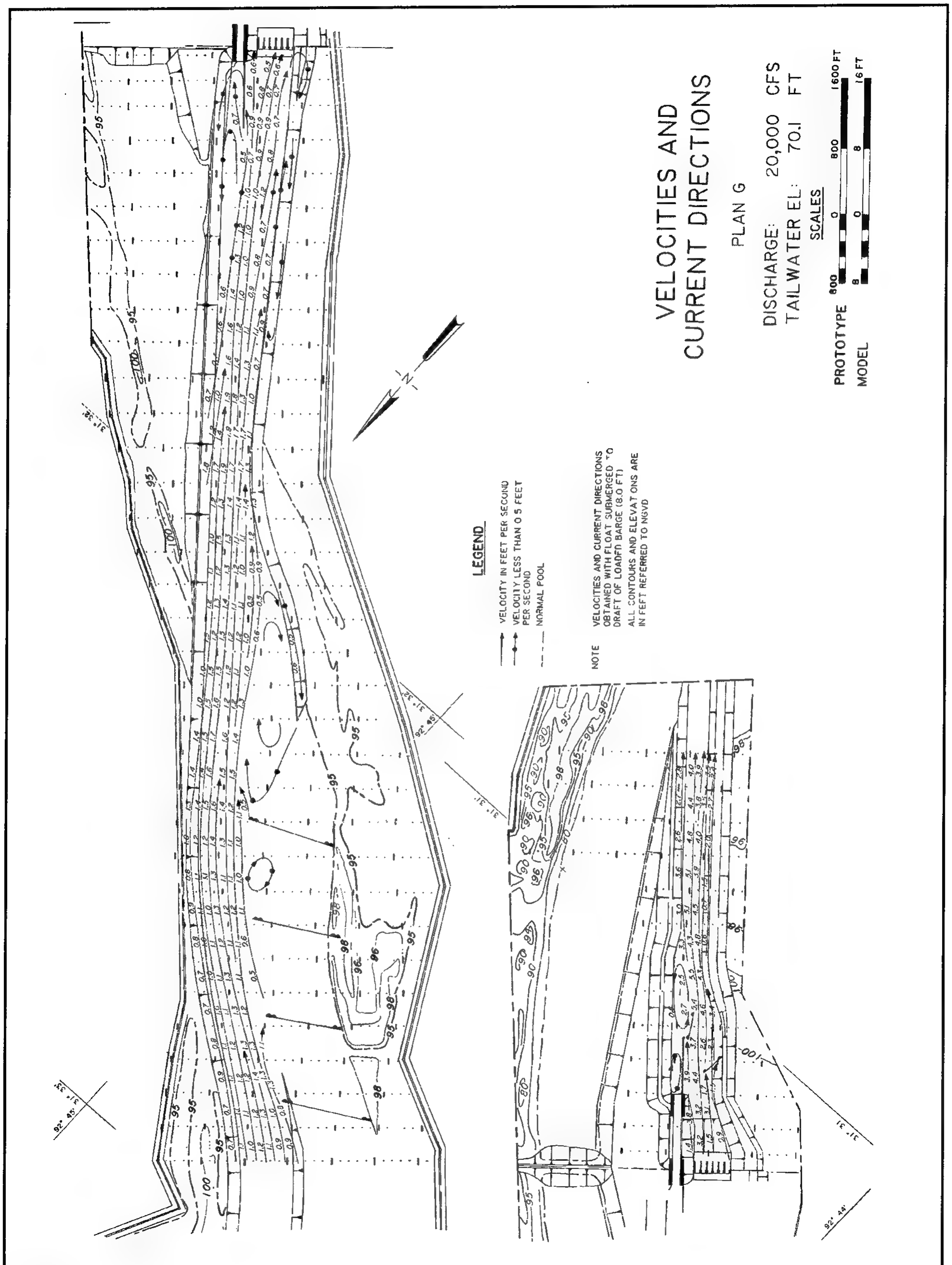
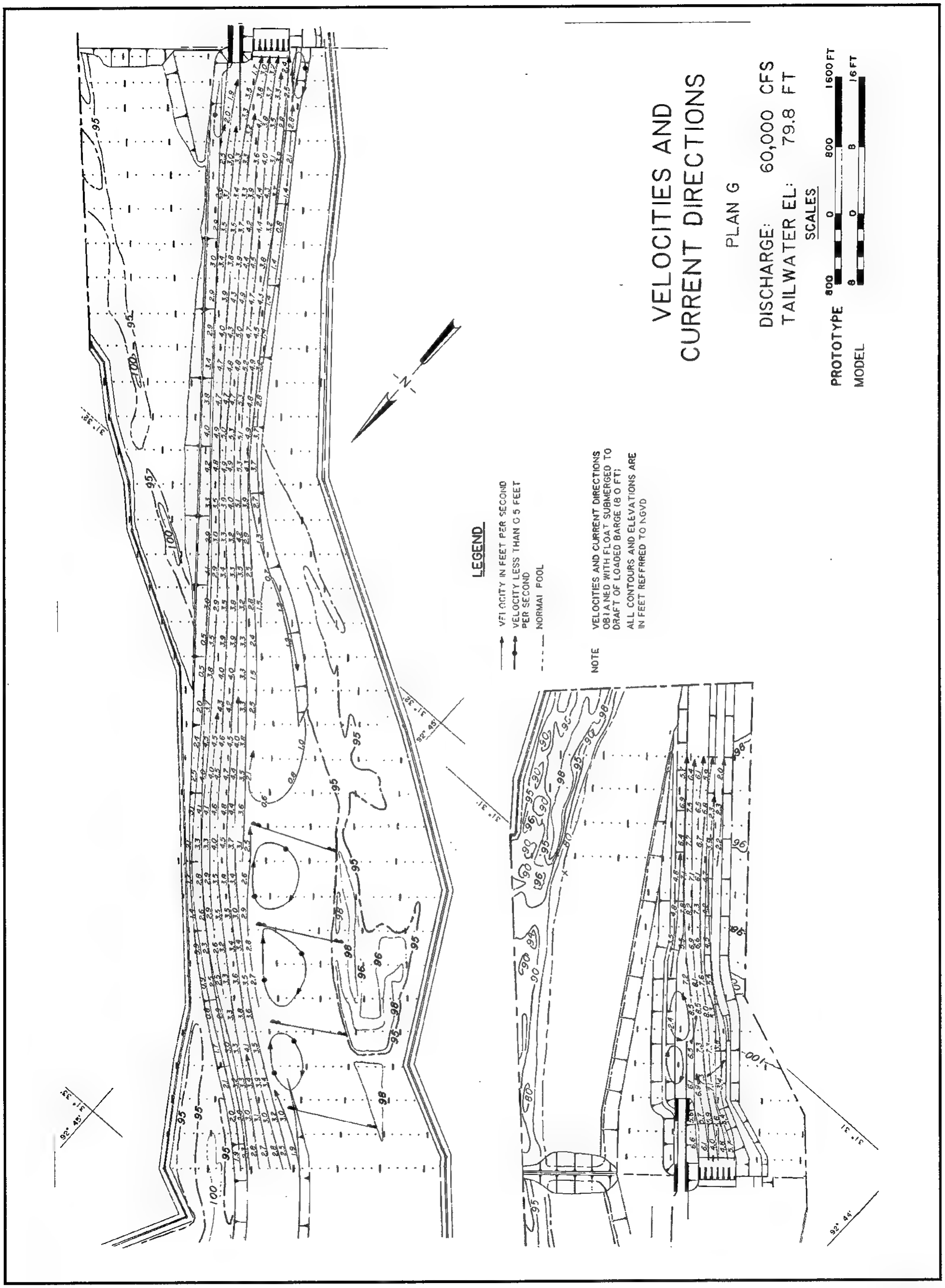

VELOCITIES AND
CURRENT DIRECTIONS
PLAN G
DISCHARGE: 20,000 CFS
TAILWATER EL: 70.1 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
N

Plate 32


VELOCITIES AND CURRENT DIRECTIONS
PLAN G
DISCHARGE: 60,000 CFS
TAILWATER EL: 79.8 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
N

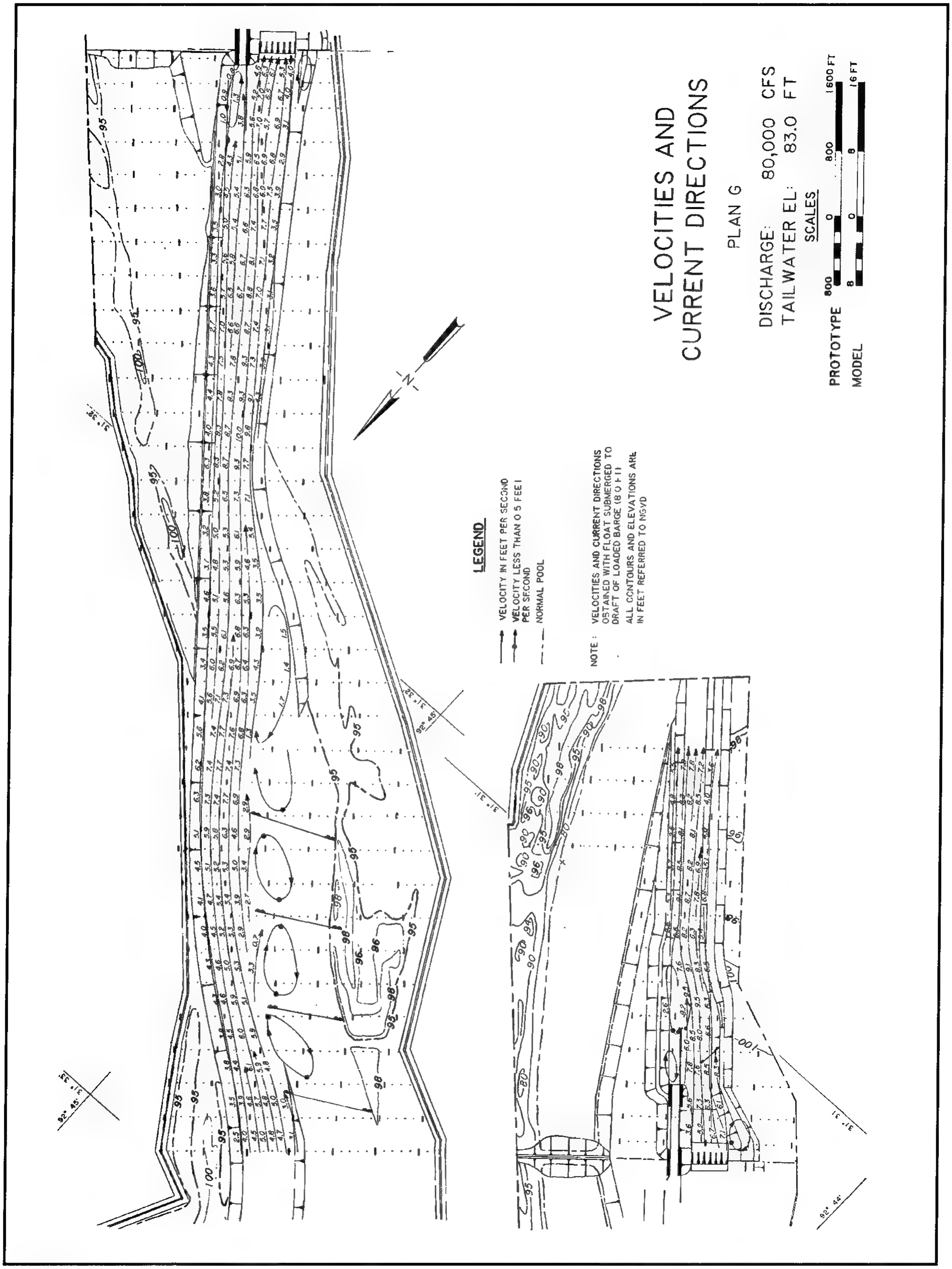
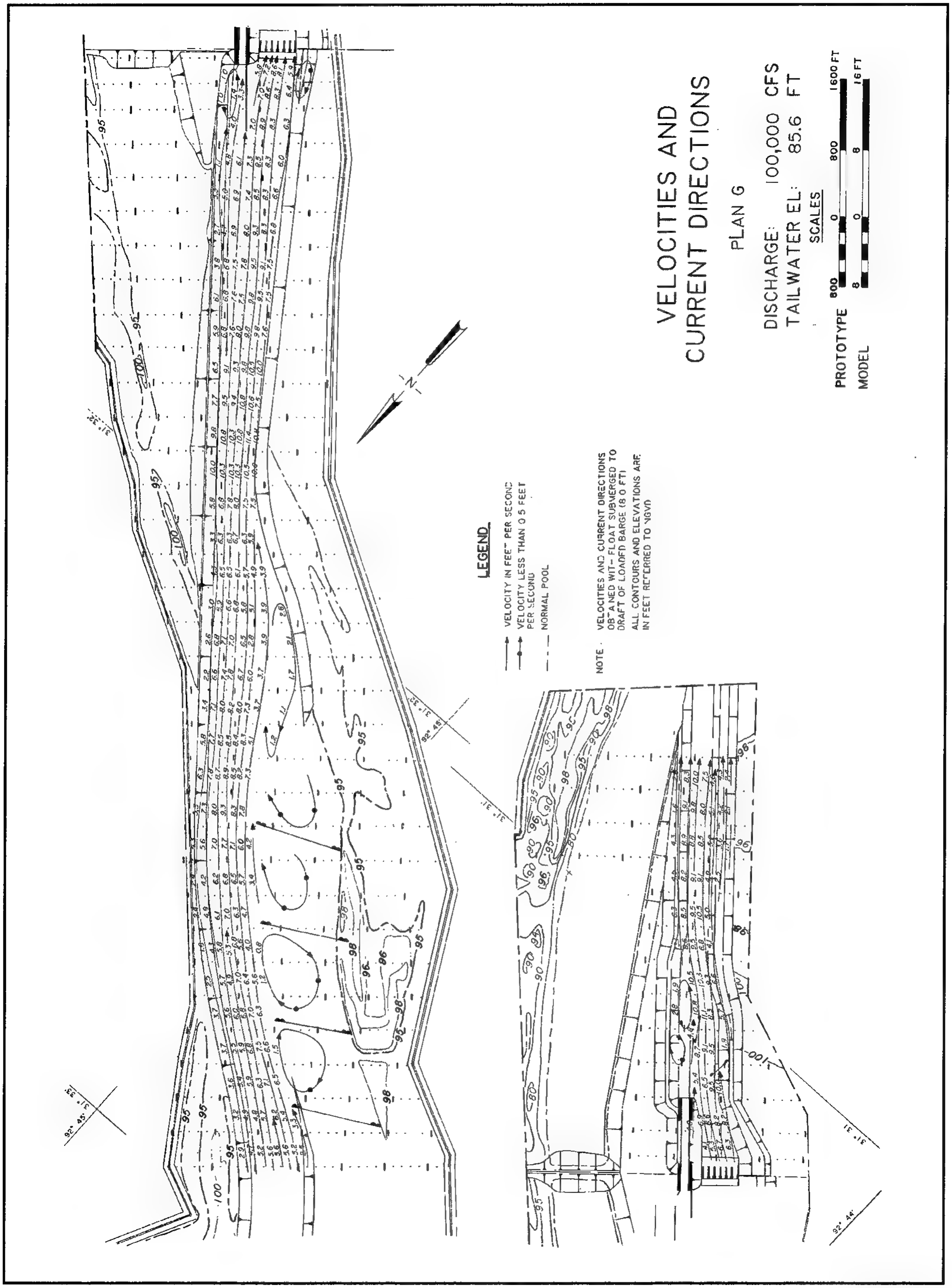

VELOCITIES AND
CURRENT DIRECTIONS
PLAN G
DISCHARGE: 80,000 CFS
TAILWATER EL: 83.0 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

Plate 34


VELOCITIES AND CURRENT DIRECTIONS
PLAN G
DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
N

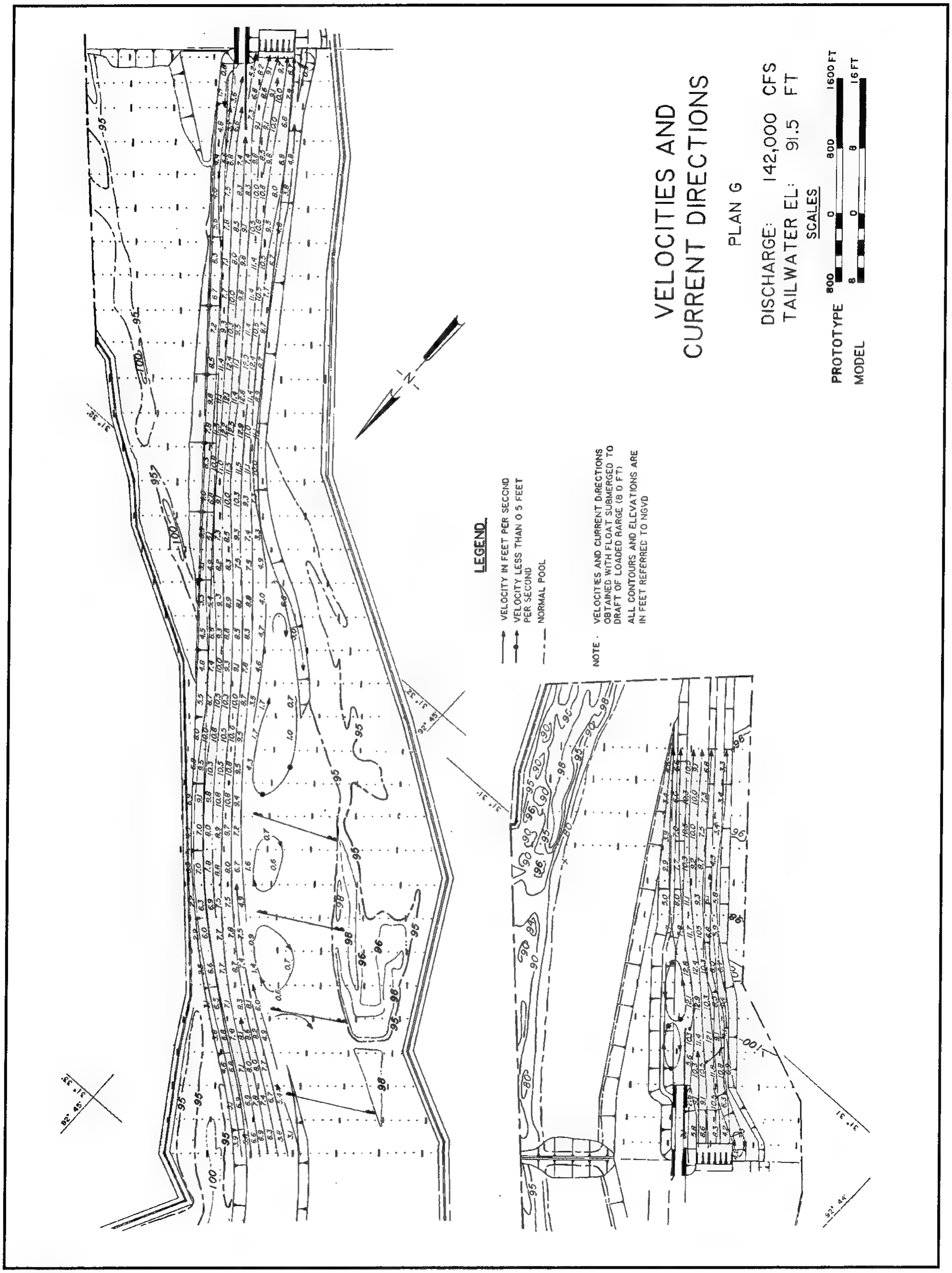
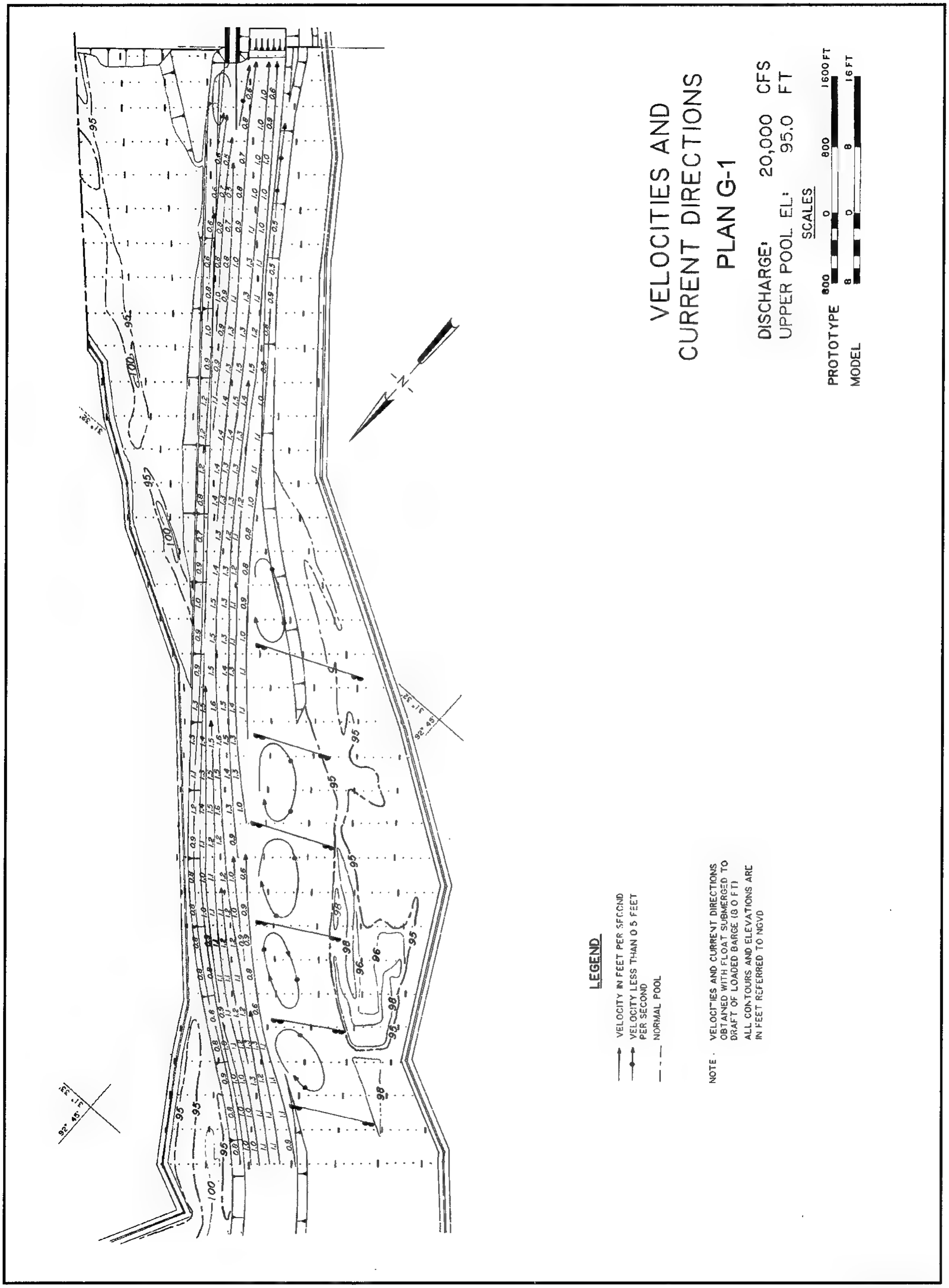
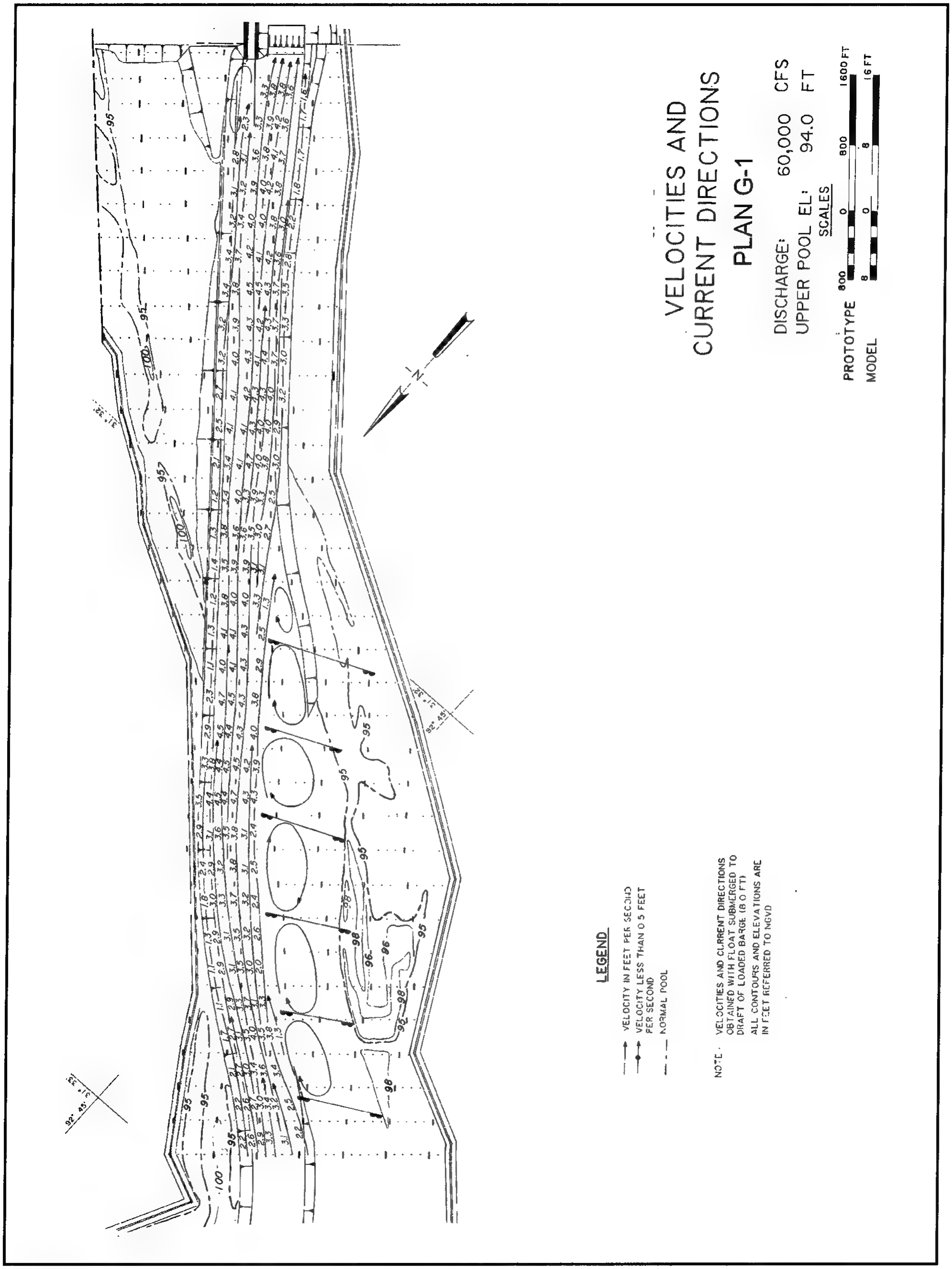
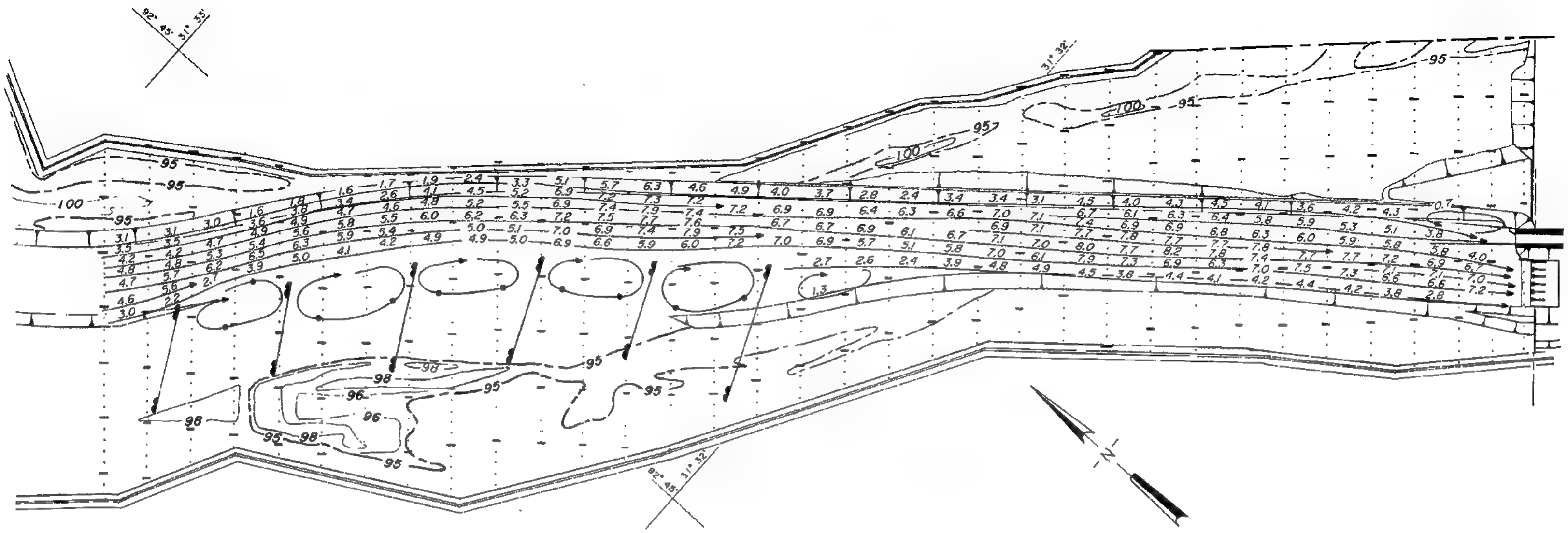

VELOCITIES AND CURRENT DIRECTIONS
PLAN G
DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

Plate 36


VELOCITIES AND CURRENT DIRECTIONS
PLAN G-1
DISCHARGE: 20,000 CFS
UPPER POOL EL: 95.0 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD


VELOCITIES AND CURRENT DIRECTIONS
PLAN G-1
DISCHARGE: 60,000 CFS
UPPER POOL EL: 94.0 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD



LEGEND

- → VELOCITY IN FEET PER SECOND
- •→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- — - — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN G-1

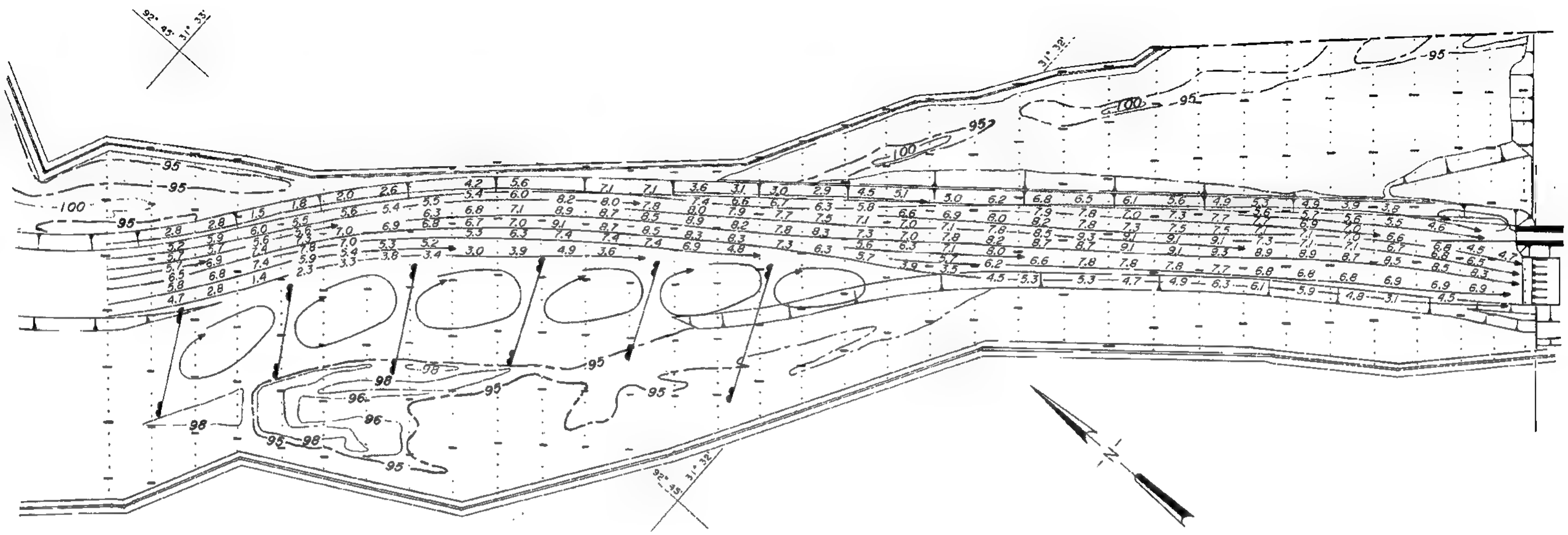
DISCHARGE: 80,000 CFS

UPPER POOL EL: 88.0 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

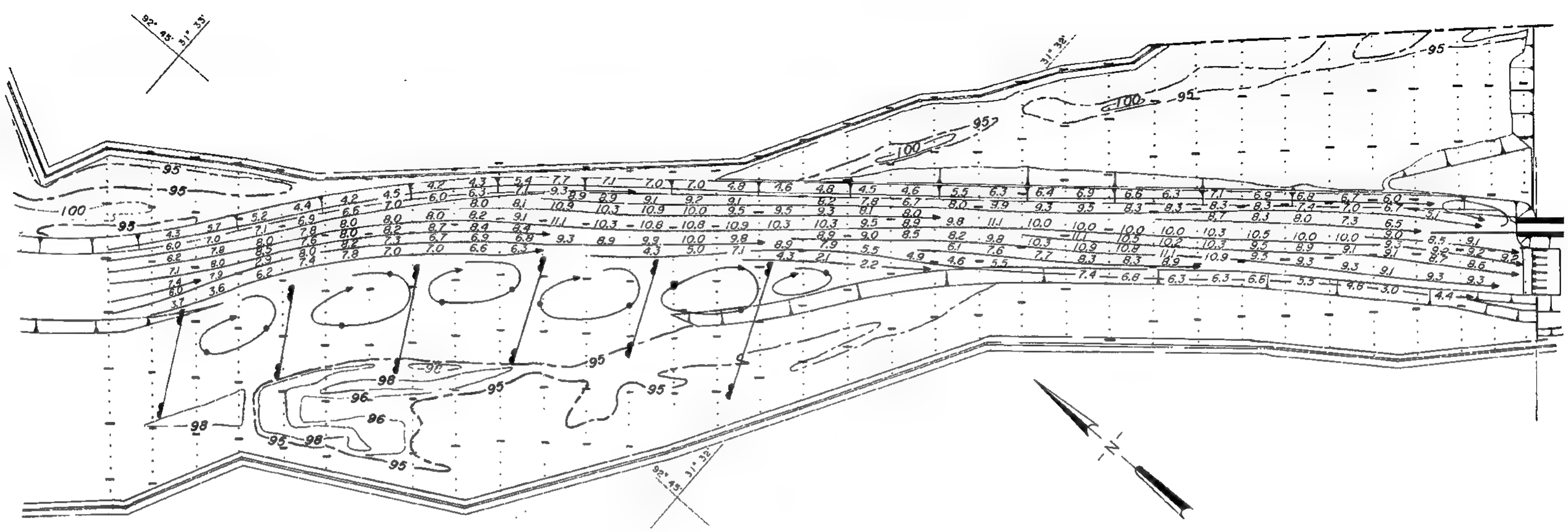
VELOCITIES AND CURRENT DIRECTIONS
PLAN G-1

DISCHARGE: 100,000 CFS
UPPER POOL EL: 89.0 FT

SCALES

PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT

Plate 40



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS PLAN G-1

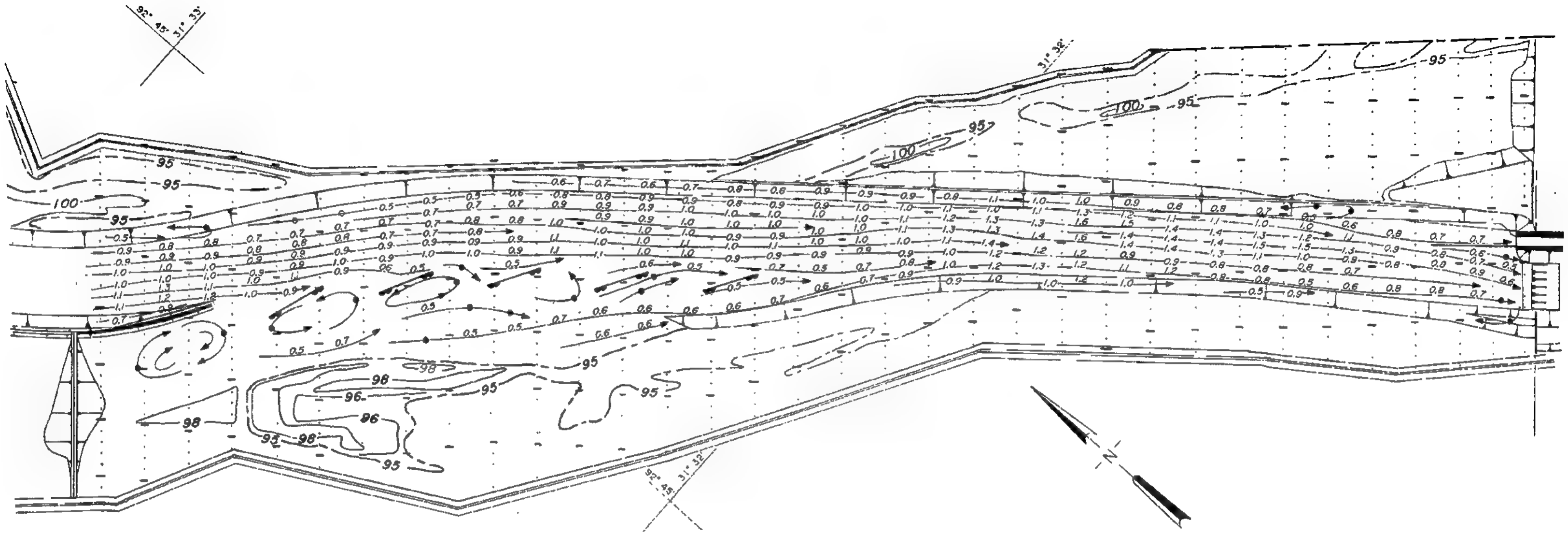
DISCHARGE: 142,000 CFS

UPPER POOL EL: 93.0 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

—•→ VELOCITY LESS THAN 0.5 FEET PER SECOND

— — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND
CURRENT DIRECTIONS
PLAN G-2

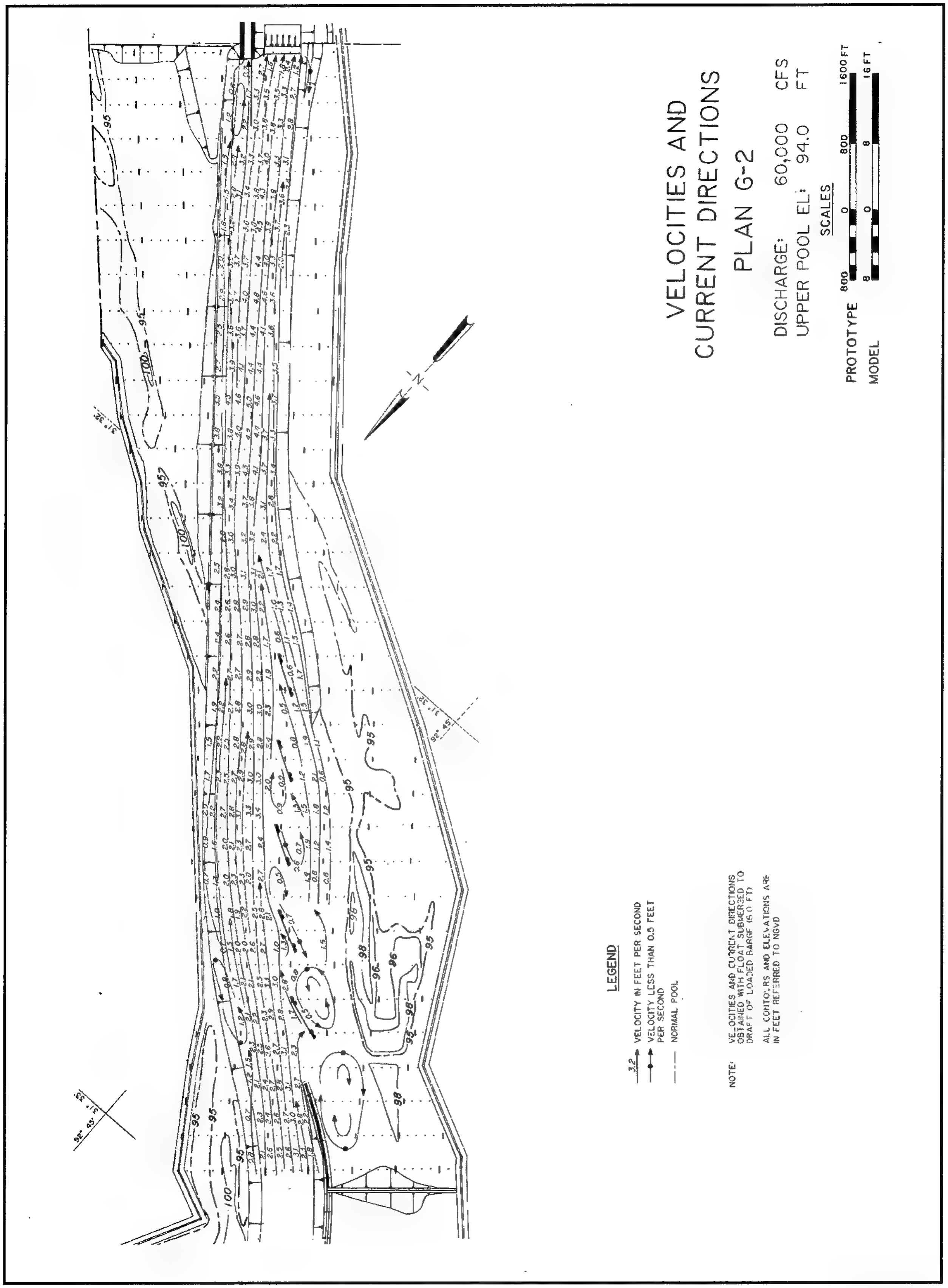
DISCHARGE: 20,000 CFS
UPPER POOL EL: 95.0 FT

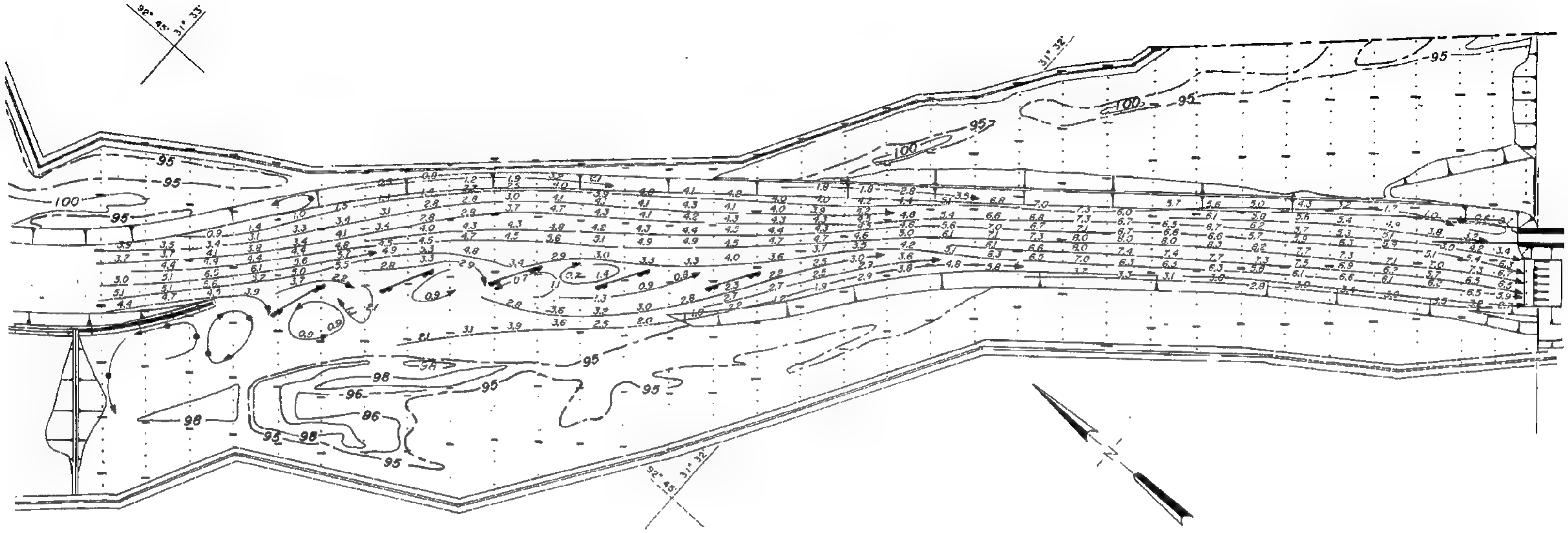
SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT

Plate 42


VELOCITIES AND
CURRENT DIRECTIONS
PLAN G-2
DISCHARGE: 60,000 CFS
UPPER POOL EL: 94.0 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD



LEGEND

3.2 → VELOCITY IN FEET PER SECOND
→ VELOCITY LESS THAN 0.5 FEET PER SECOND
— · — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).

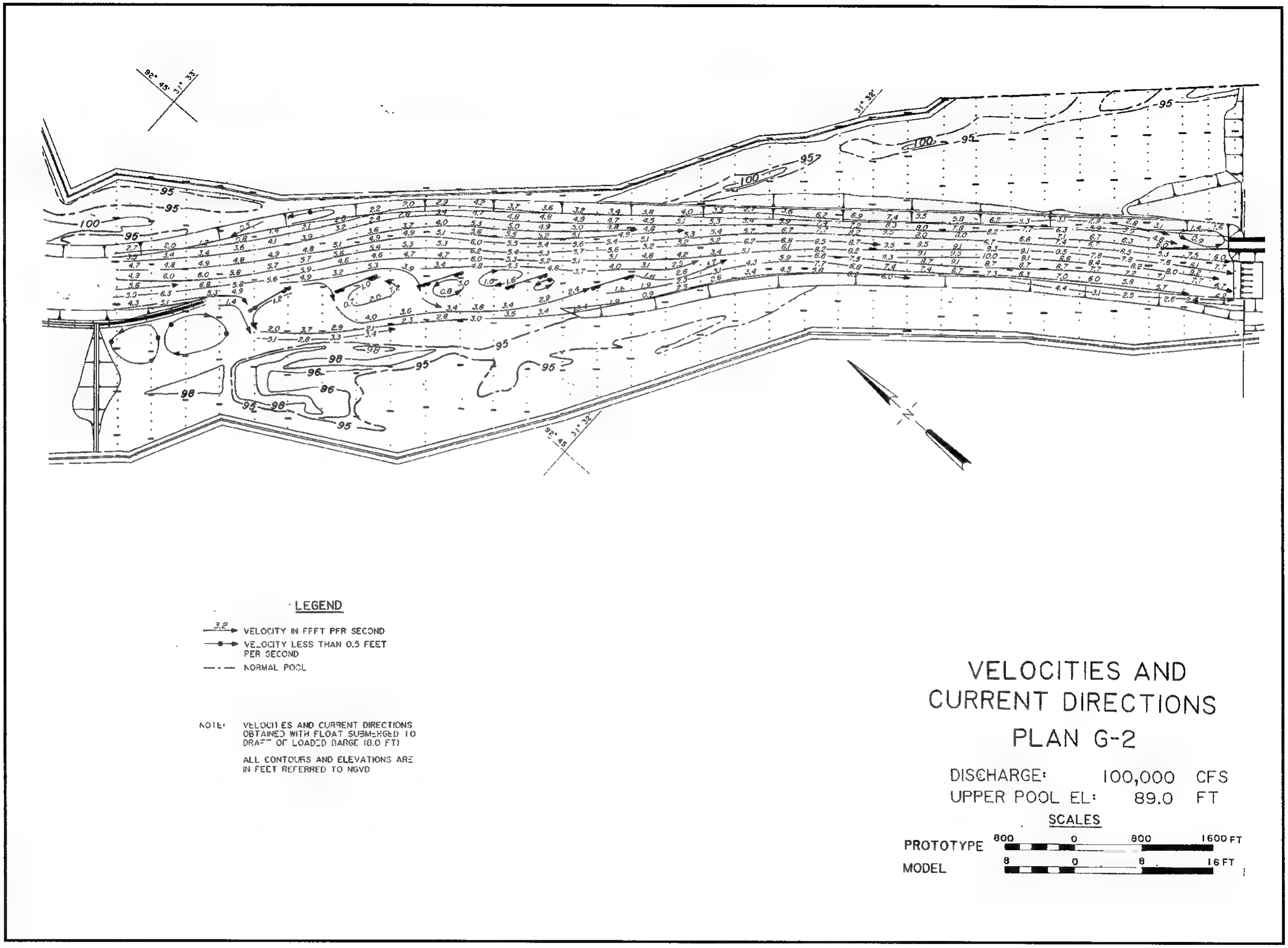
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS
PLAN G-2

DISCHARGE:	80,000	CFS
UPPER POOL EL:	88.0	FT

SCALES

PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT


VELOCITIES AND CURRENT DIRECTIONS
PLAN G-2
DISCHARGE: 100,000 CFS
UPPER POOL EL: 89.0 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

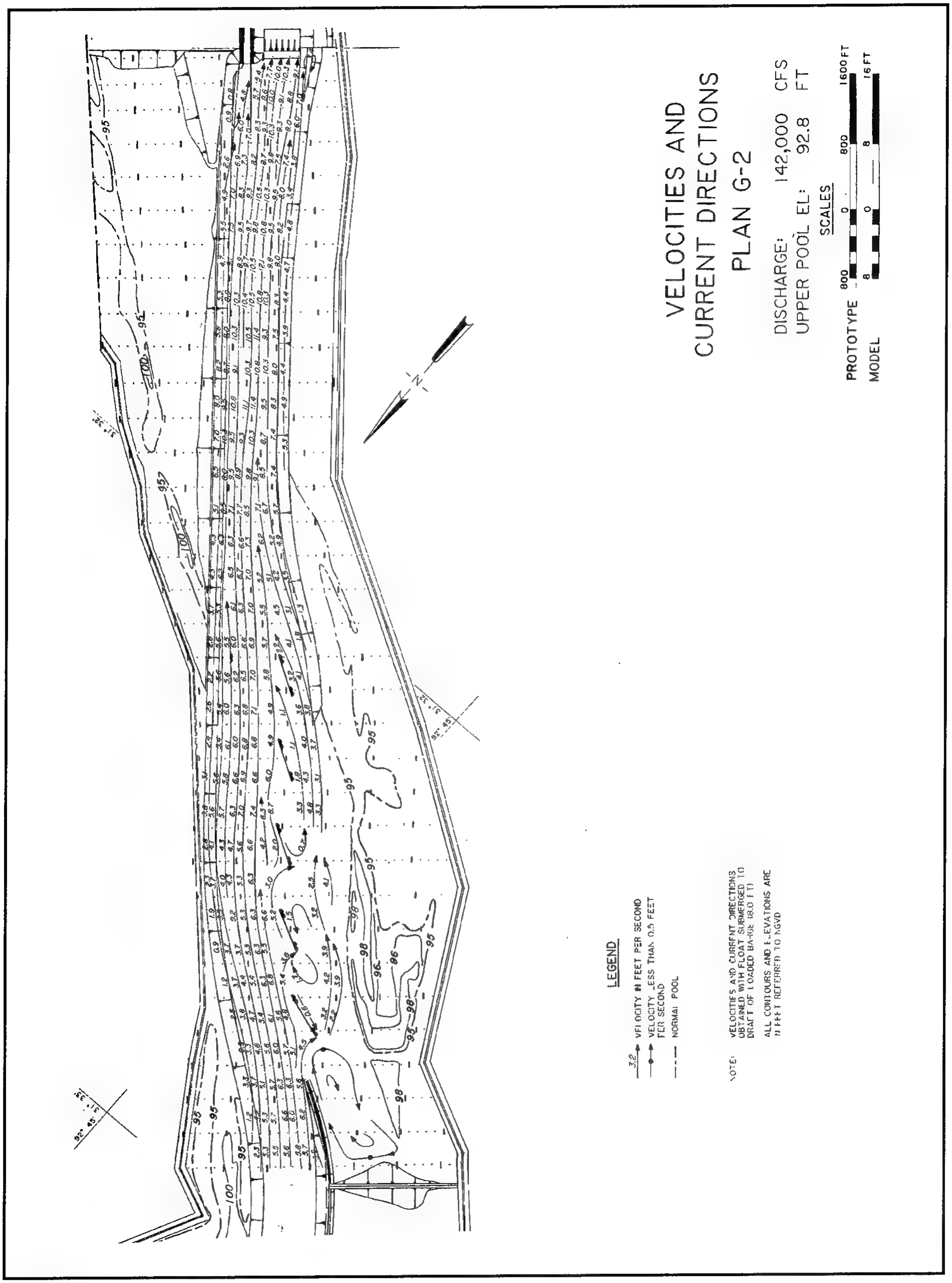
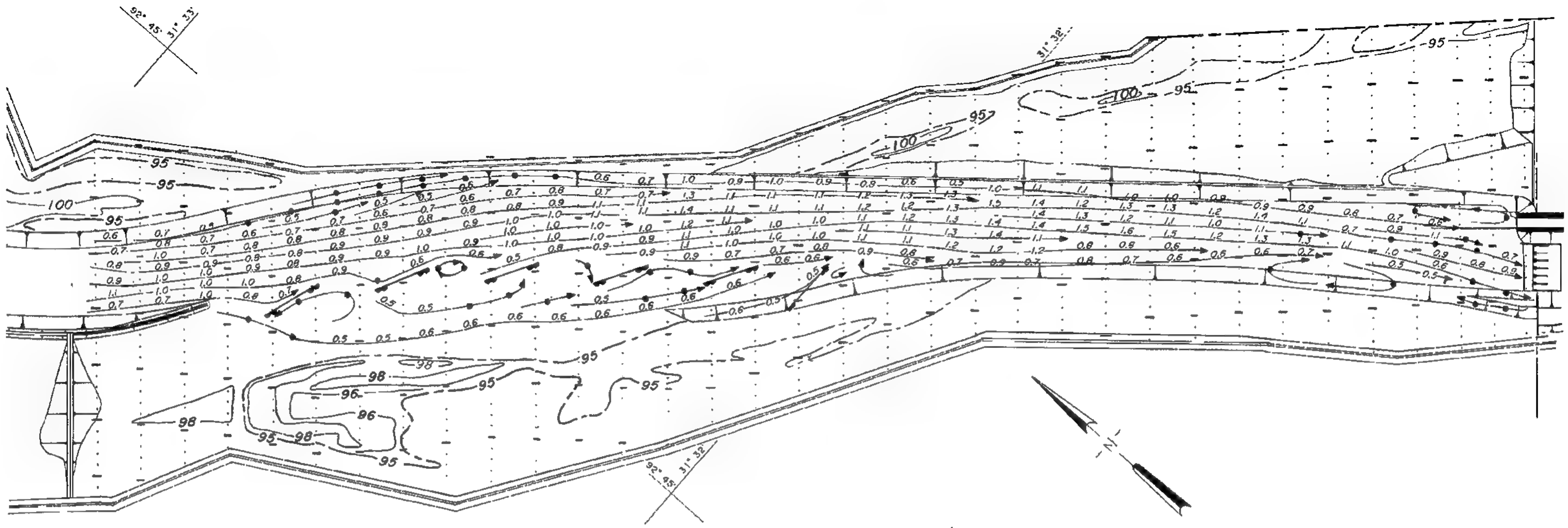

VELOCITIES AND
CURRENT DIRECTIONS
PLAN G-2
DISCHARGE: 142,000 CFS
UPPER POOL EL: 92.8 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

Plate 46



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

—•→ VELOCITY LESS THAN 0.5 FEET PER SECOND

—·— NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN G-3

DISCHARGE: 20,000 CFS
UPPER POOL EL: 95.0 FT

SCALES

PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT

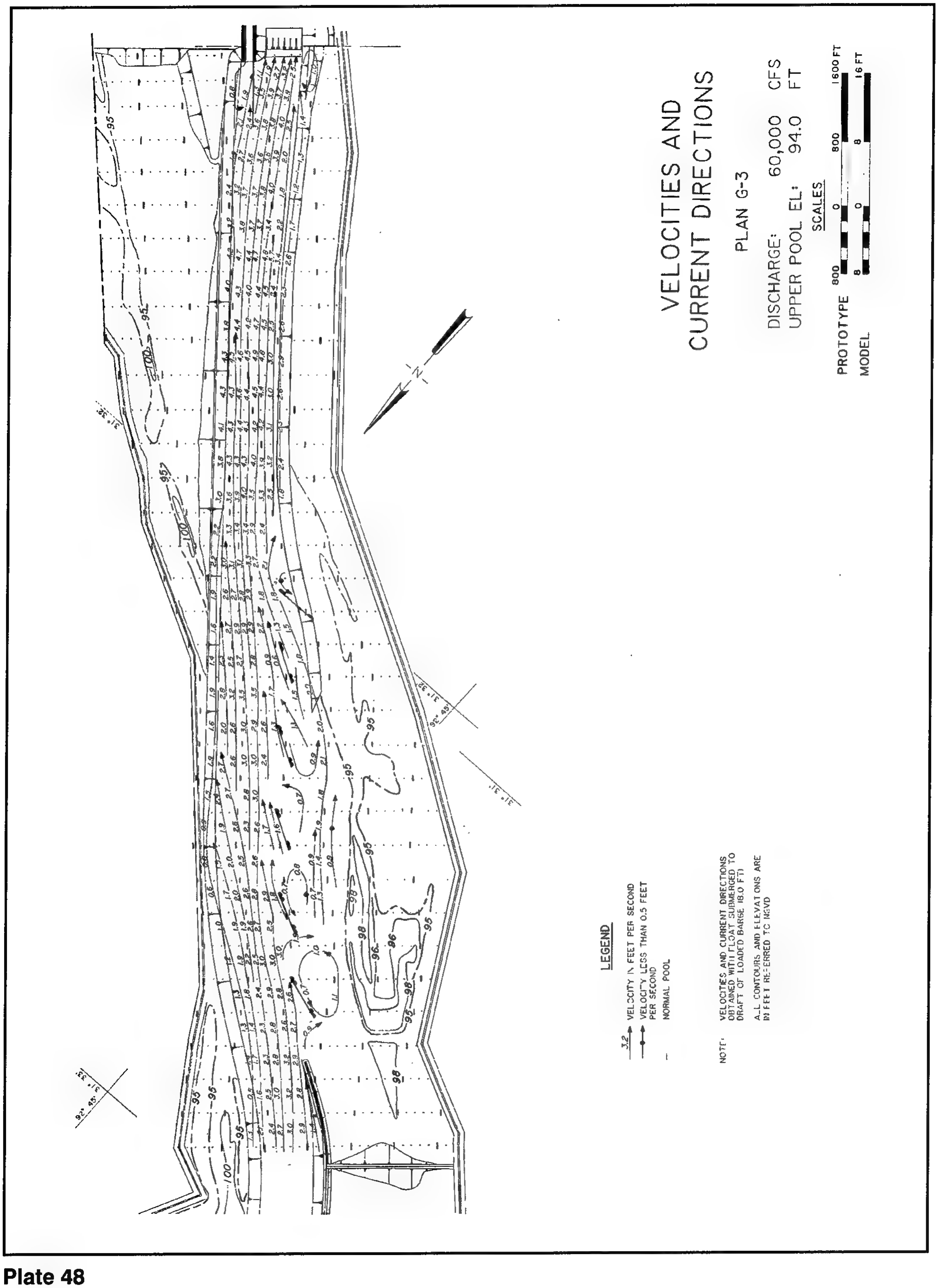
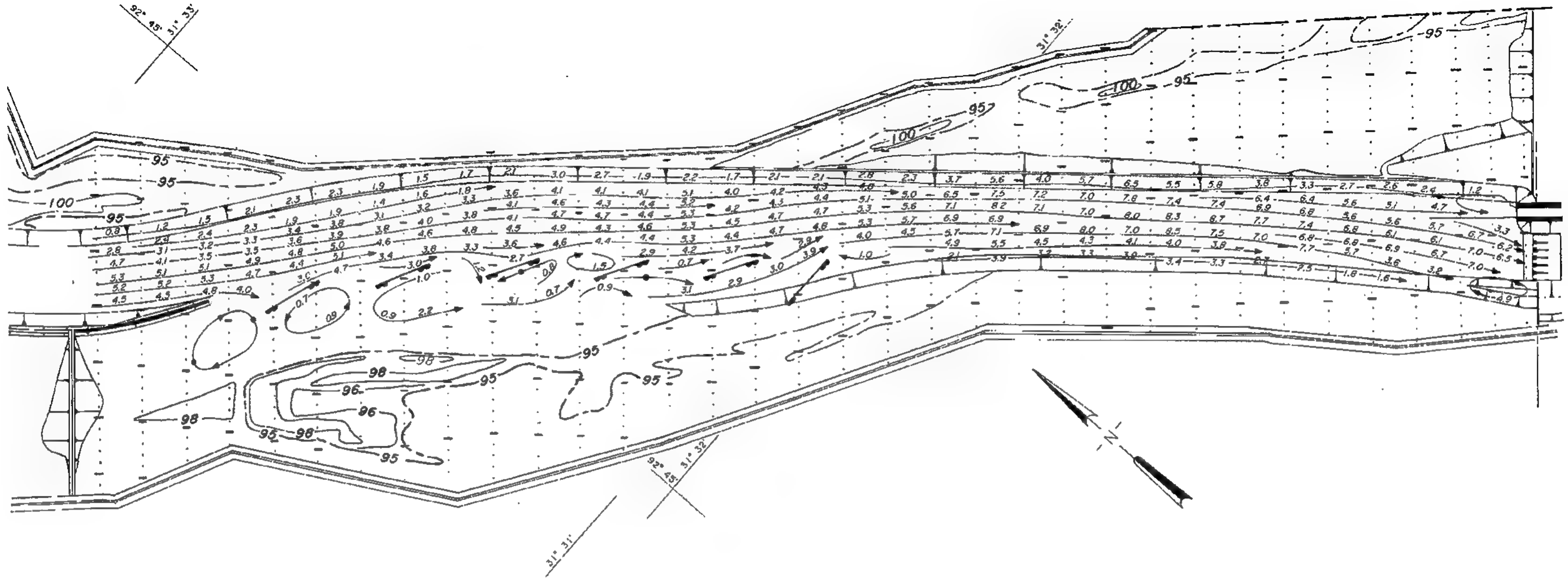

VELOCITIES AND
CURRENT DIRECTIONS
PLAN G-3
DISCHARGE: 60,000 CFS
UPPER POOL EL: 94.0 FT
SCALES
PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

Plate 48



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN G-3

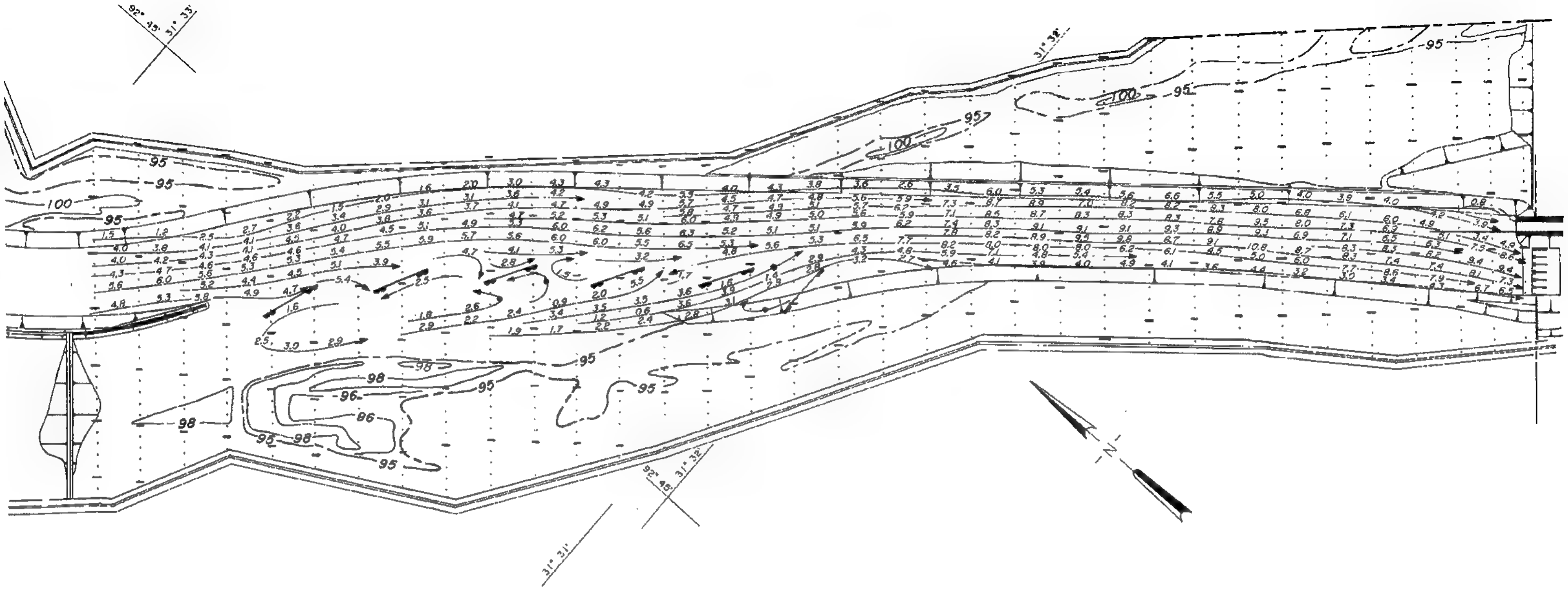
DISCHARGE: 80,000 CFS

UPPER POOL EL: 88.0 FT

SCALES

PROTOTYPE 800 0 800 1600 FT

MODEL 8 0 8 16 FT



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

—•→ VELOCITY LESS THAN 0.5 FEET PER SECOND

- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN G-3

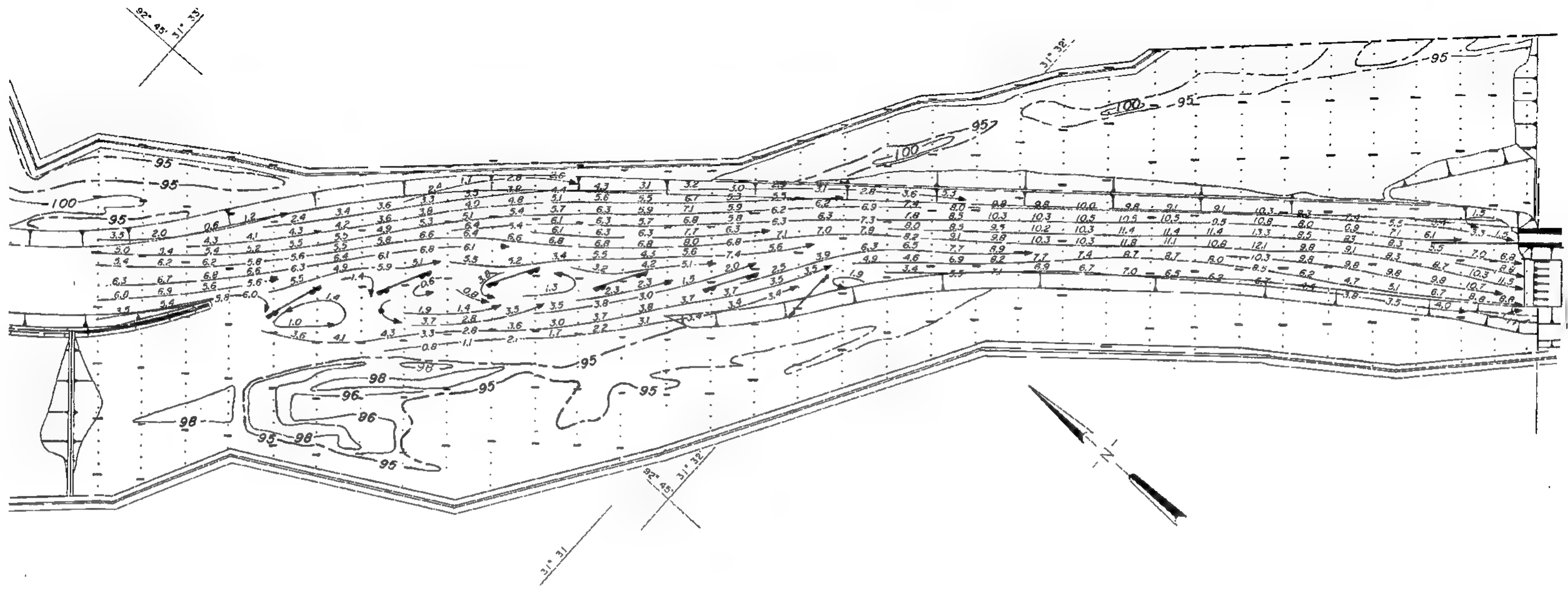
DISCHARGE: 100,000 CFS

UPPER POOL EL: 89.0 FT

SCALES

PROTOTYPE	800	0	800	1600 FT
MODEL	8	0	8	16 FT

Plate 50



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- —•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- — · — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

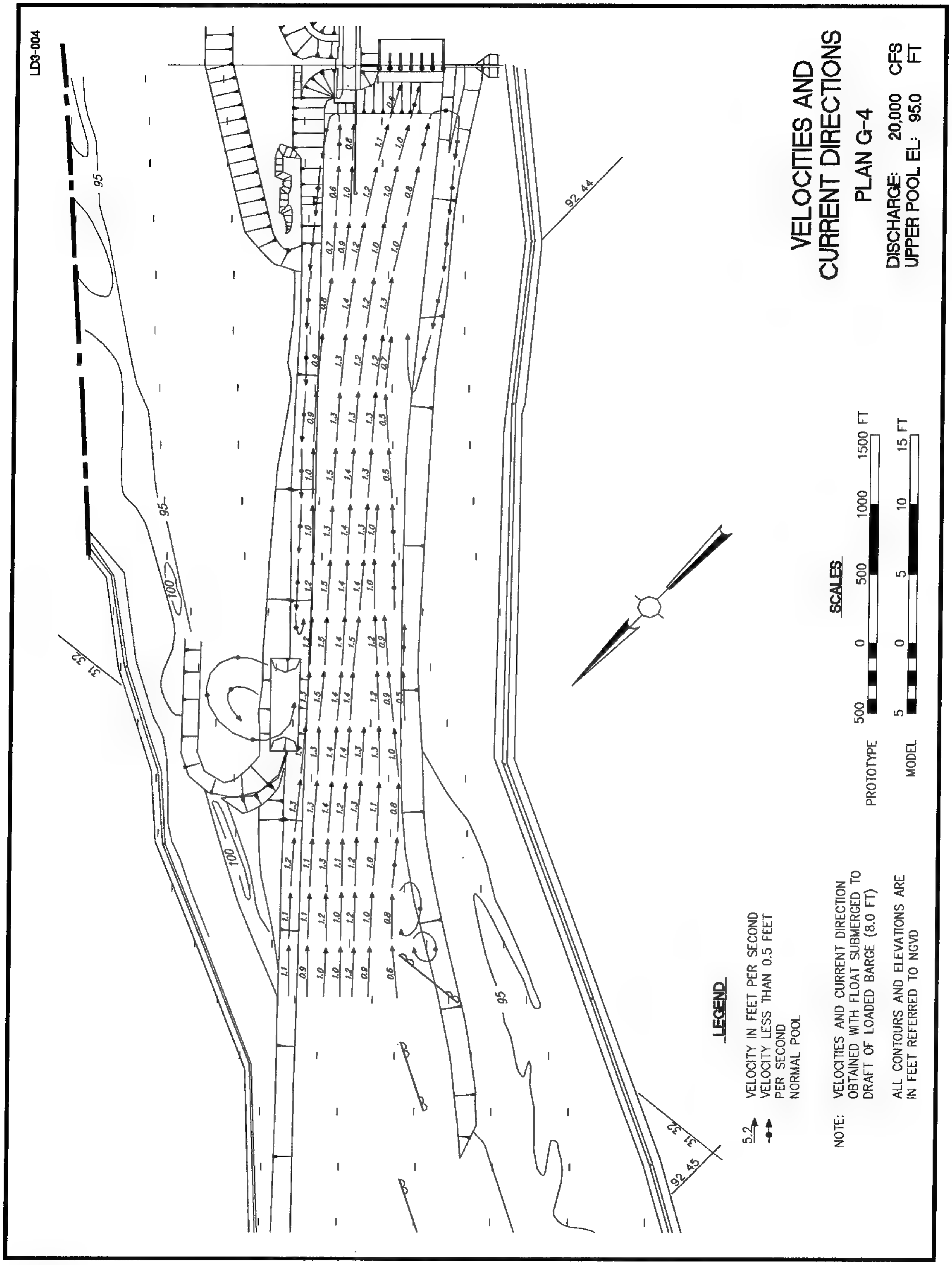
VELOCITIES AND CURRENT DIRECTIONS

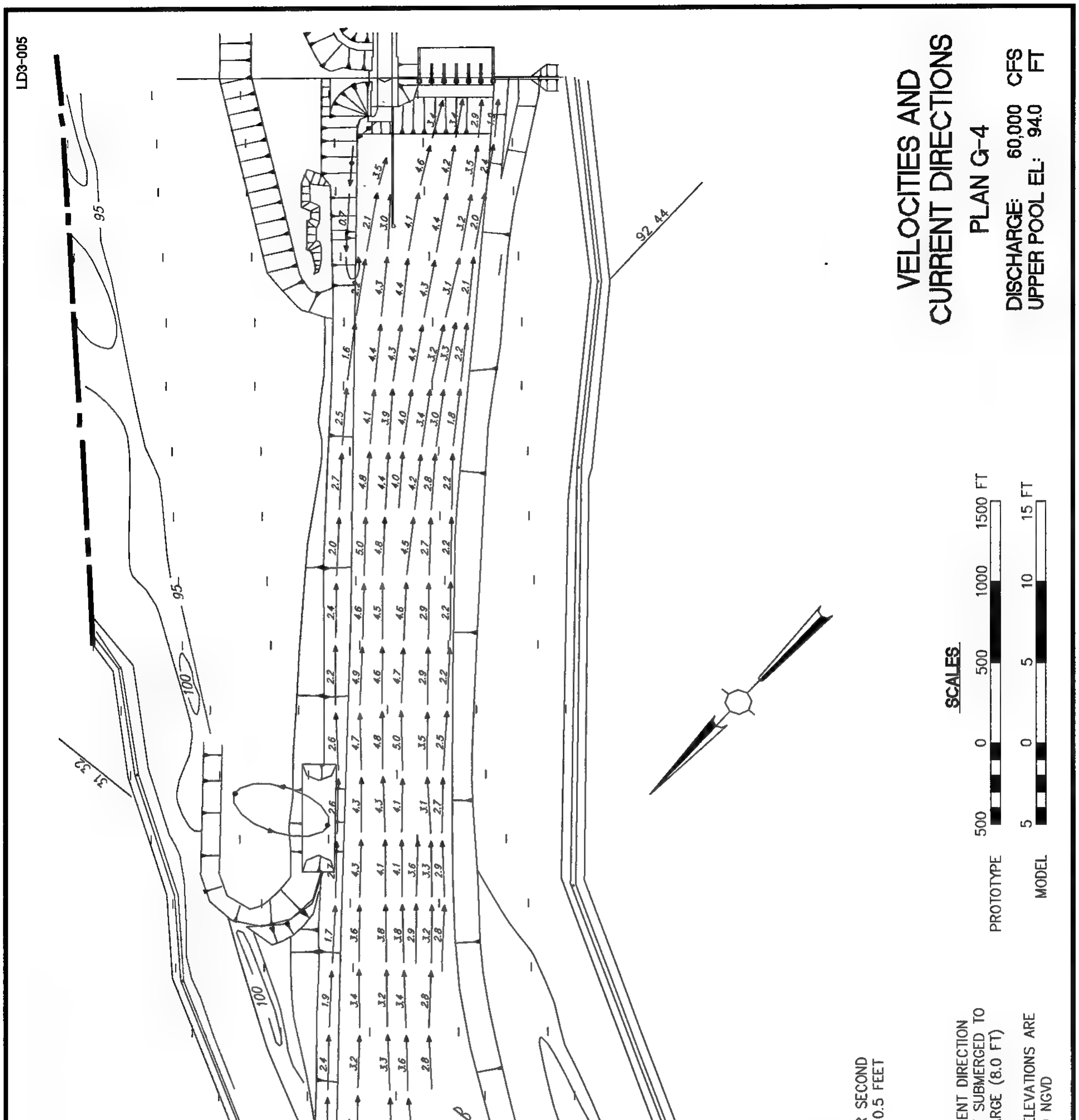
PLAN G-3

DISCHARGE: 142,000 CFS
UPPER POOL EL: 92.8 FT

SCALES

PROTOTYPE 800 0 800 1600 FT
MODEL 8 0 8 16 FT


LD3-004
VELOCITIES AND
CURRENT DIRECTIONS
PLAN G-4
DISCHARGE: 20,000 CFS
UPPER POOL EL: 95.0 FT
LEGEND
5.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SCALES
PROTOTYPE 500 0 500 1000 1500 FT
MODEL 5 0 5 10 15 FT


LD3-005
VELOCITIES AND
CURRENT DIRECTIONS
PLAN G-4
DISCHARGE: 60,000 CFS
UPPER POOL EL: 94.0 FT
LEGEND
5.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SCALES
PROTOTYPE 500 0 500 1000 1500 FT
MODEL 5 0 5 10 15 FT

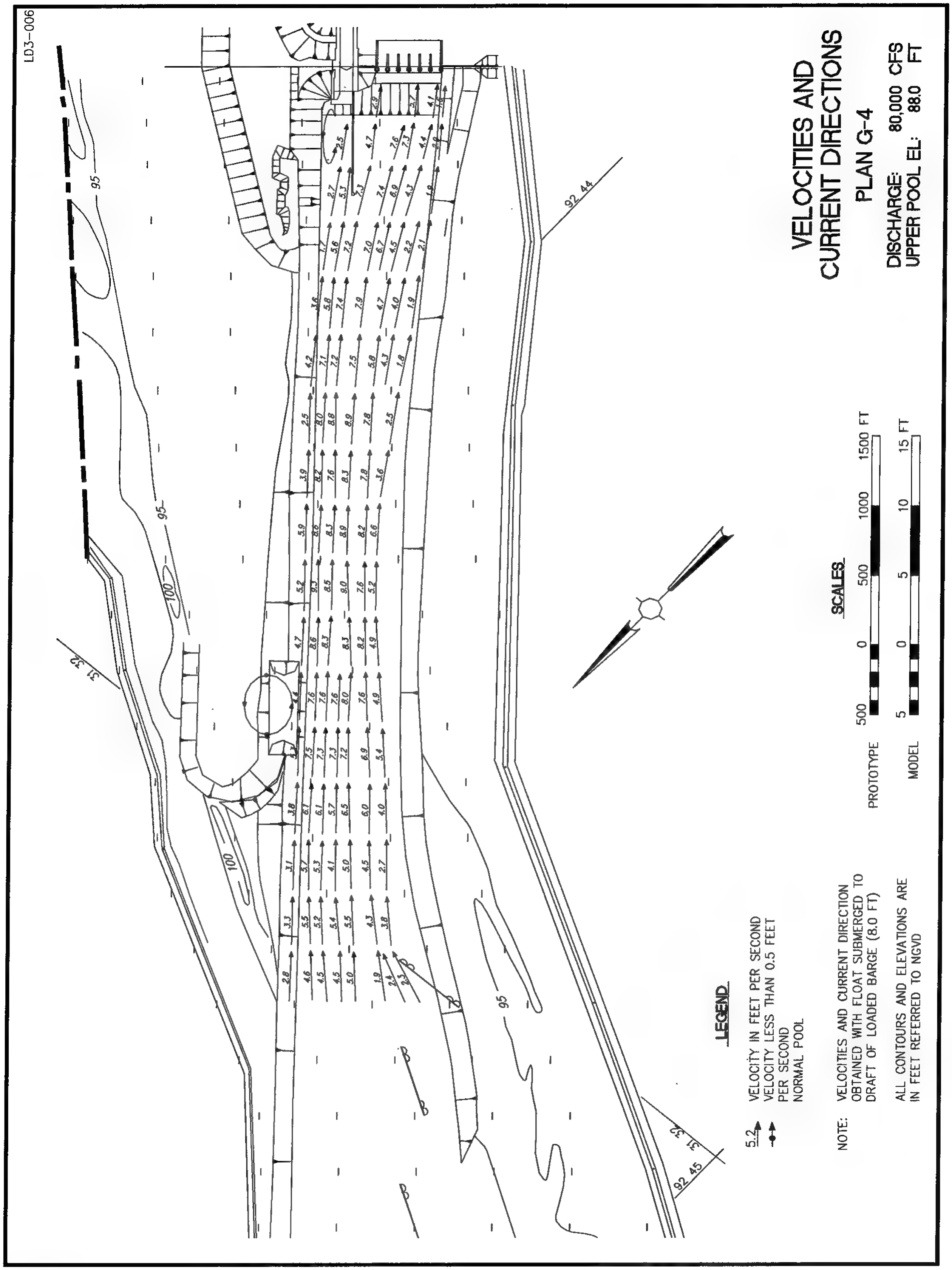
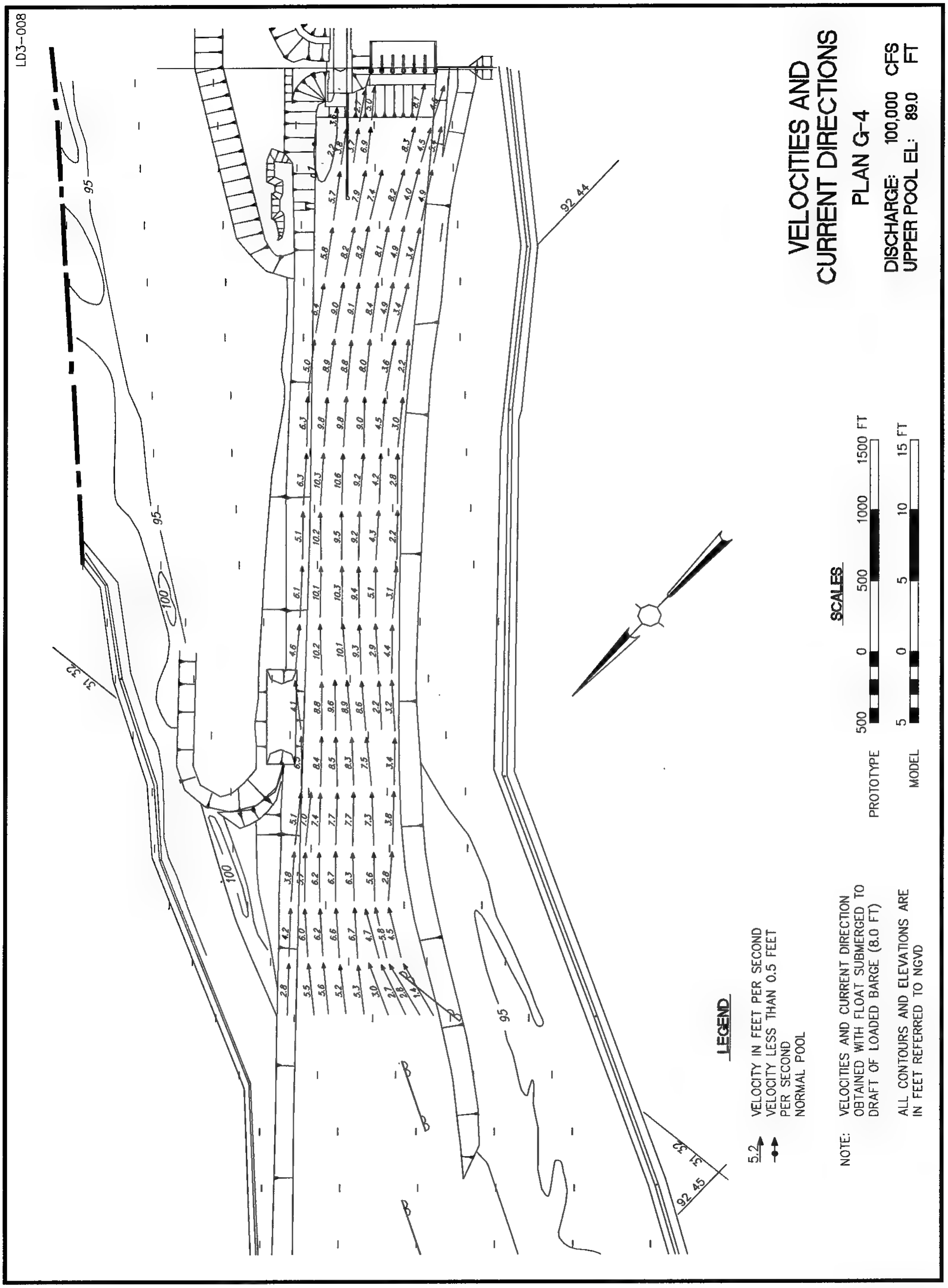
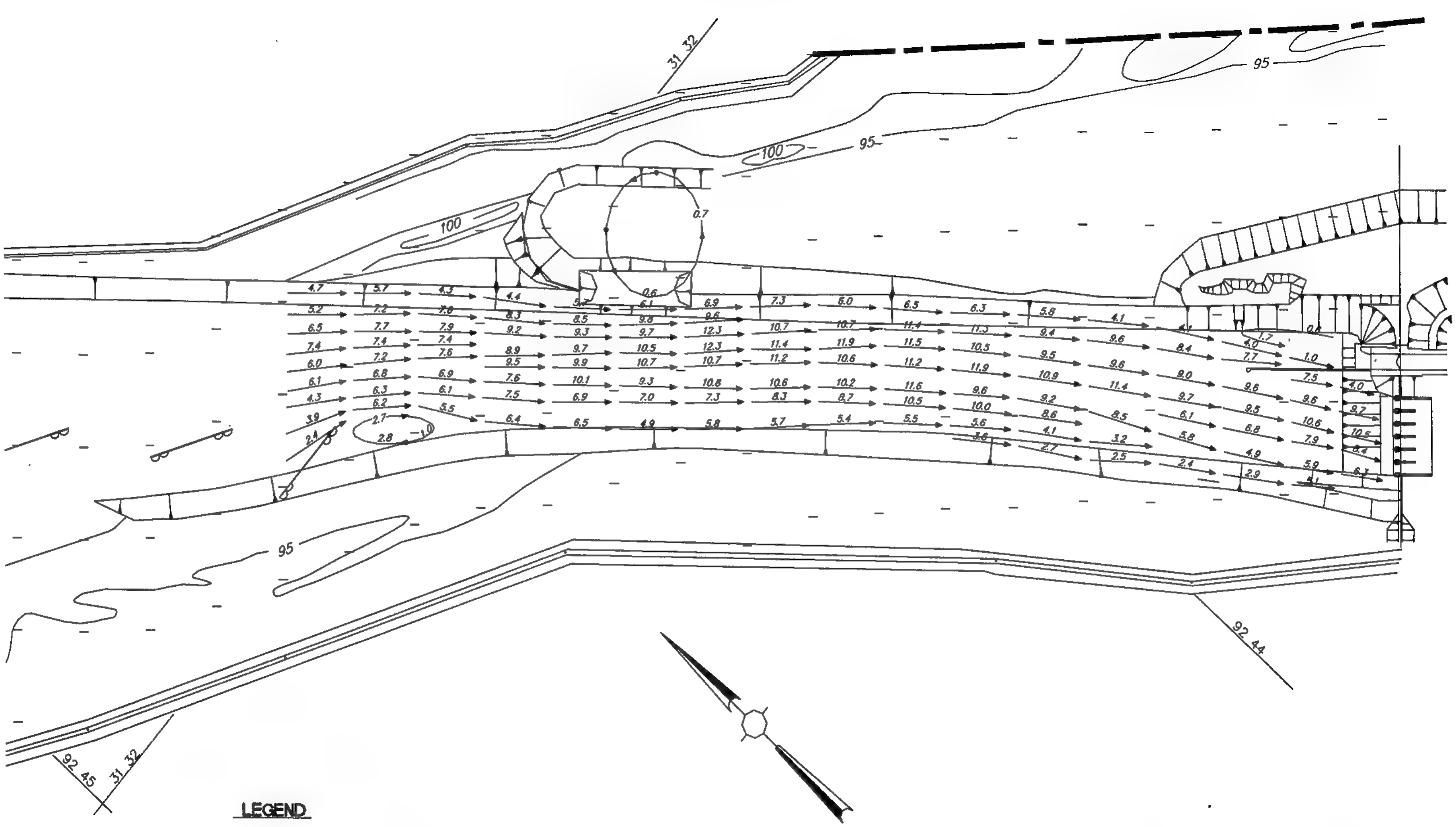

LD3-006
VELOCITIES AND
CURRENT DIRECTIONS
PLAN G-4
DISCHARGE: 80,000 CFS
UPPER POOL EL: 88.0 FT
LEGEND
5.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SCALES
PROTOTYPE
500 0 500 1000 1500 FT
MODEL
5 0 5 10 15 FT
95
100
92 44
92 45
31 32

Plate 54



LD3-008
VELOCITIES AND CURRENT DIRECTIONS
PLAN G-4
DISCHARGE: 100,000 CFS
UPPER POOL EL: 89.0 FT
LEGEND
5.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SCALES
PROTOTYPE 500 0 500 1000 1500 FT
MODEL 5 0 5 10 15 FT

LD3-007



LEGEND

5.2 → VELOCITY IN FEET PER SECOND

→•→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500 FT

MODEL 5 0 5 10 15 FT

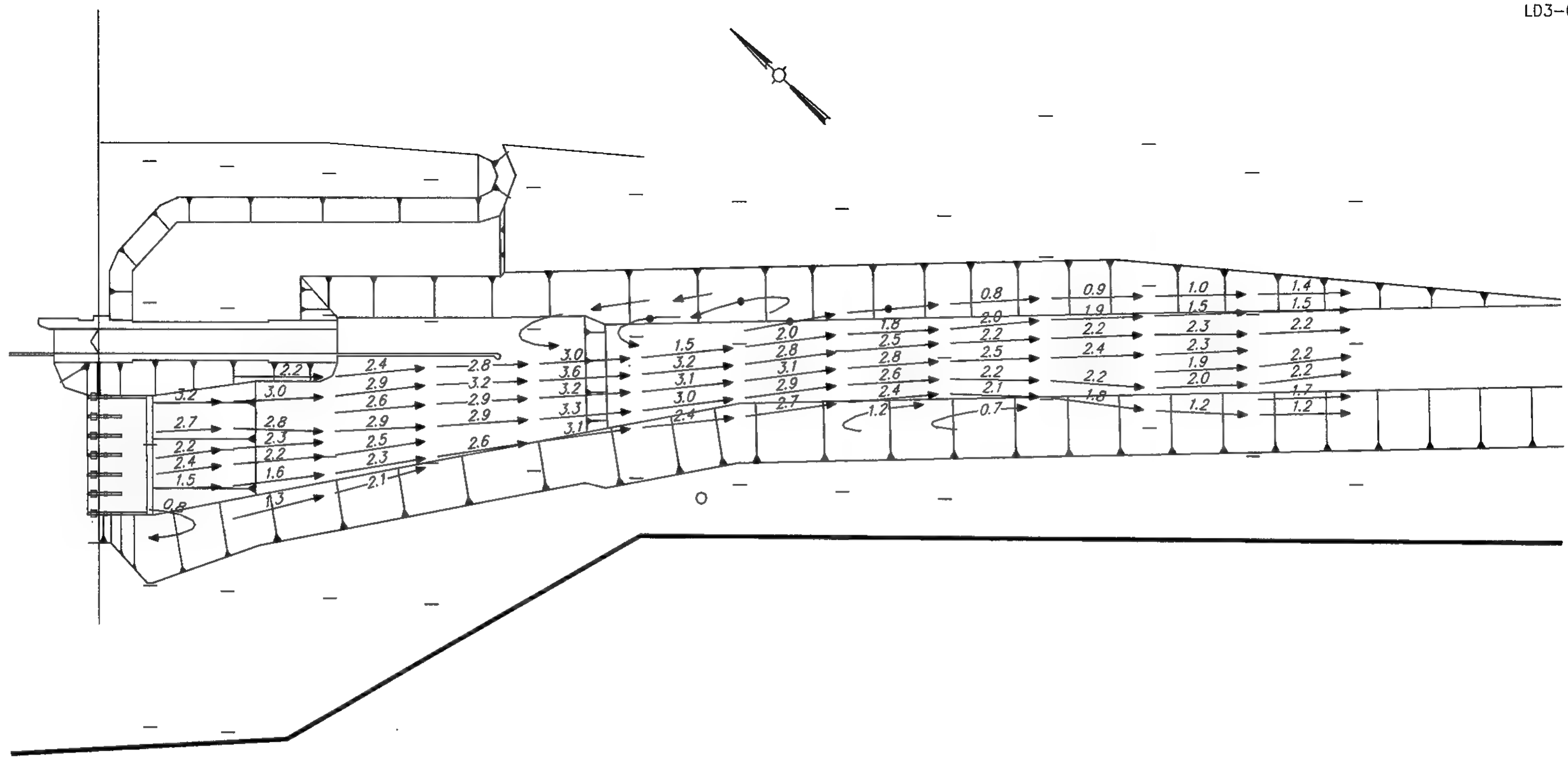
VELOCITIES AND CURRENT DIRECTIONS

PLAN G-4

DISCHARGE: 142,000 CFS

UPPER POOL EL: 92.8 FT

LD3-022



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

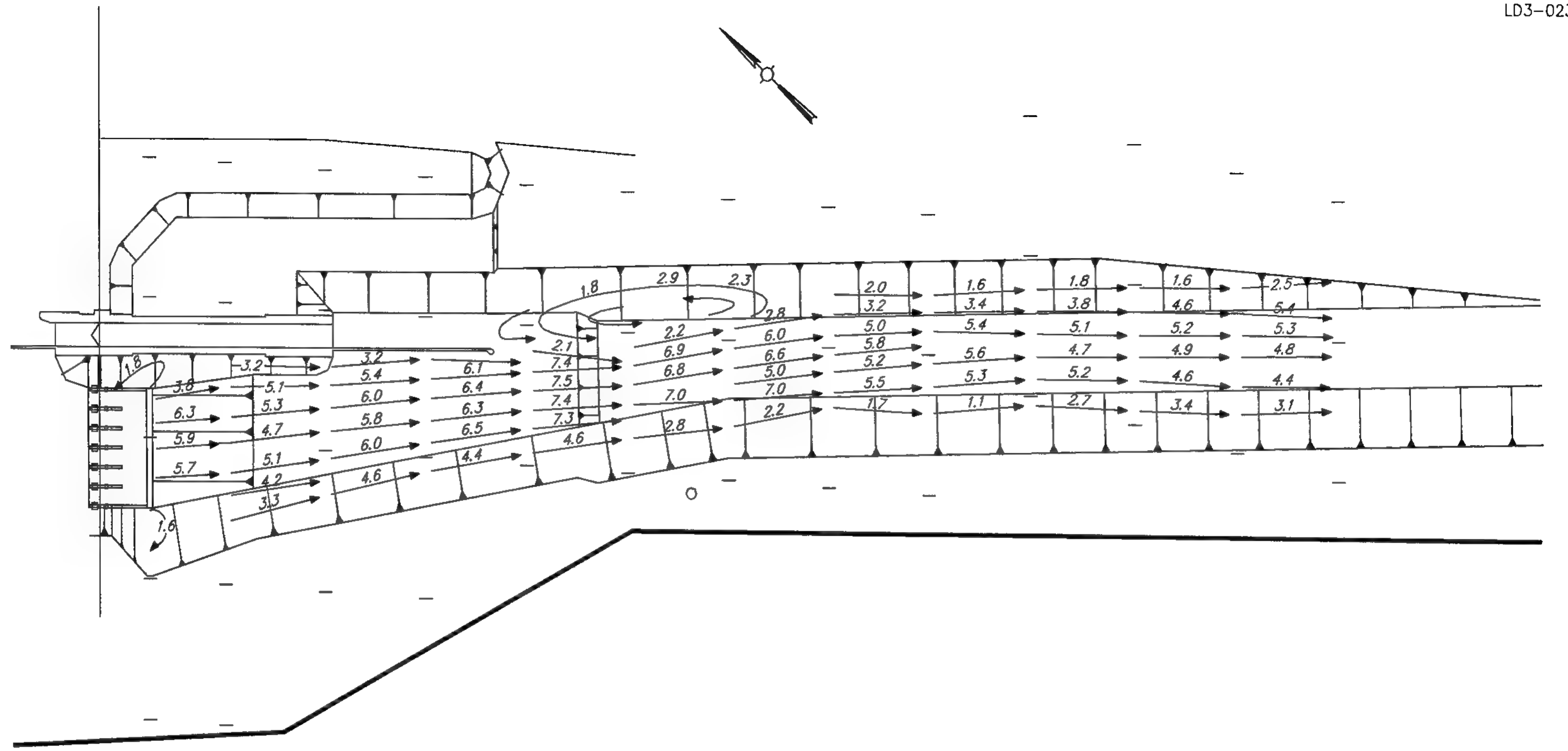
PROTOTYPE 500 0 500 1000 1500

MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H WITHOUT DIKE

DISCHARGE: 20,000 CFS
TAILWATER EL: 70.1 FT



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- —•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- ---- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

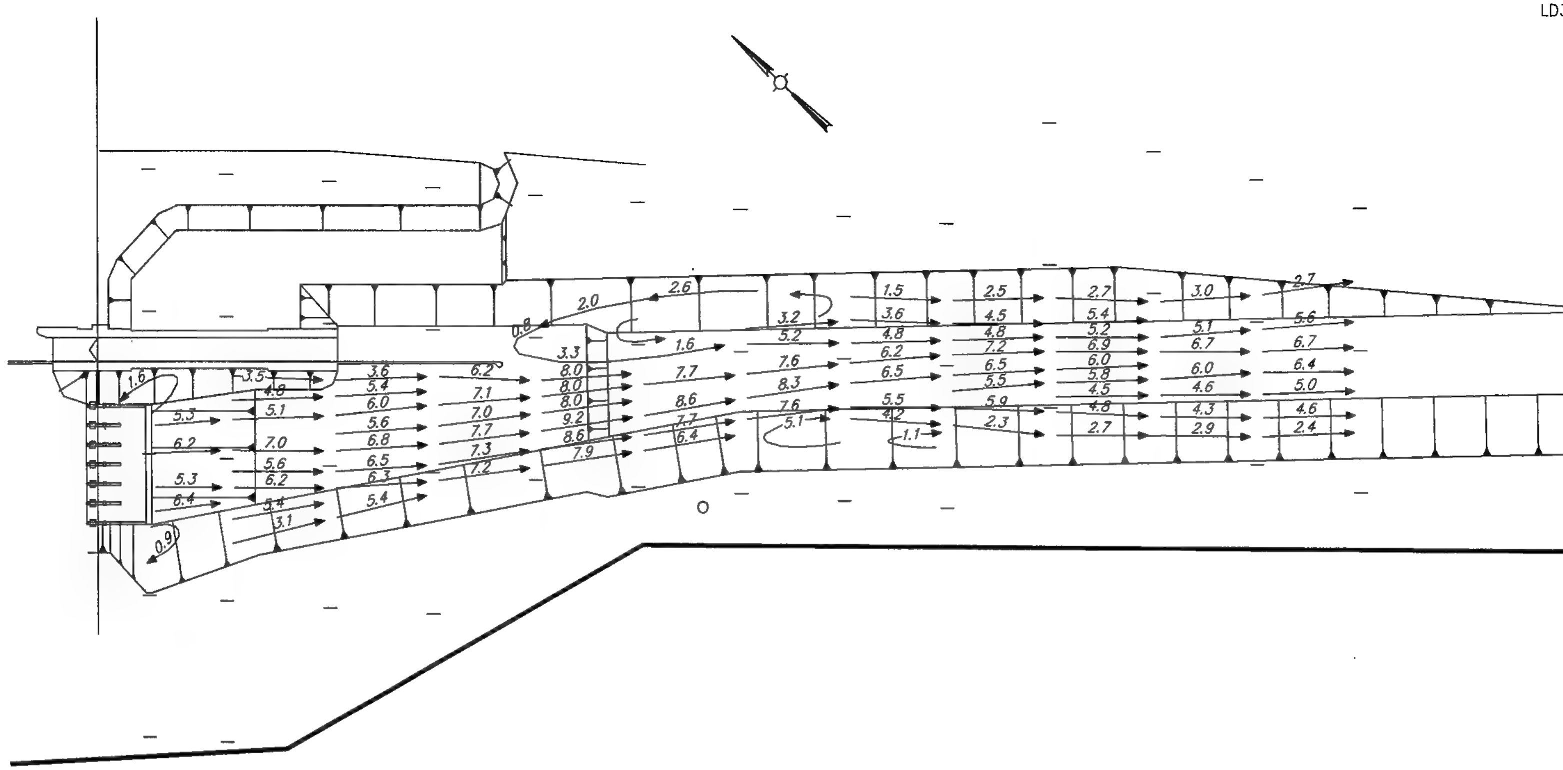
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H WITHOUT DIKE

DISCHARGE: 60,000 CFS
TAILWATER EL: 79.8 FT

LD3-026



LEGEND

3.2 → VELOCITY IN FEET PER SECOND
→ VELOCITY LESS THAN 0.5 FEET PER SECOND
— — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

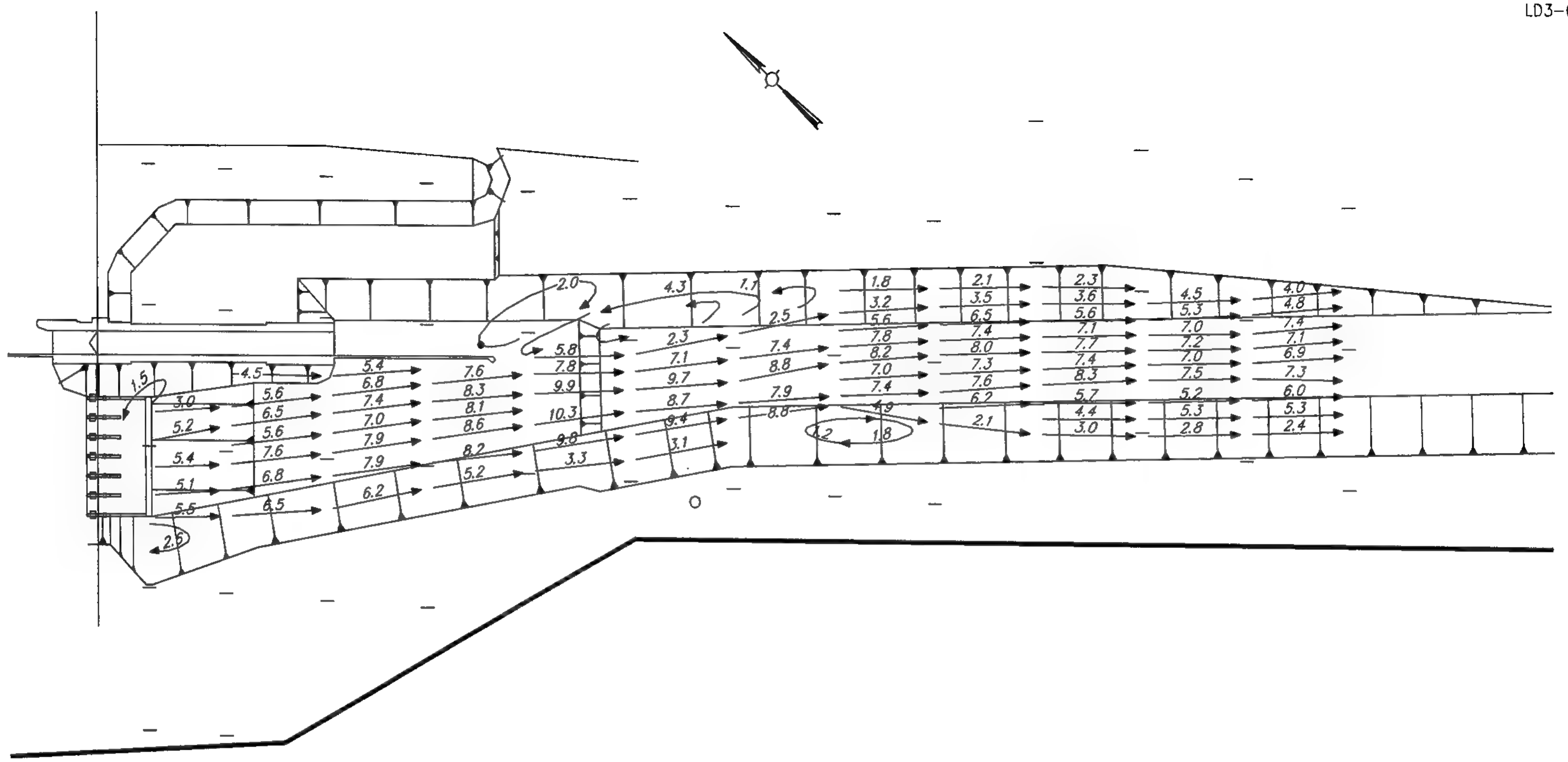
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H WITHOUT DIKE

DISCHARGE: 80,000 CFS
TAILWATER EL: 83.0 FT

LD3-030

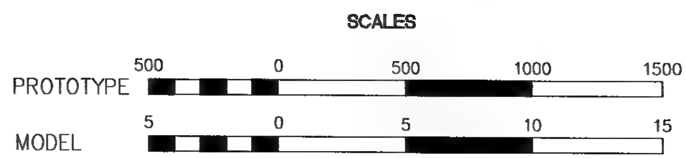


LEGEND

3.2 → VELOCITY IN FEET PER SECOND
→•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
—·— NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

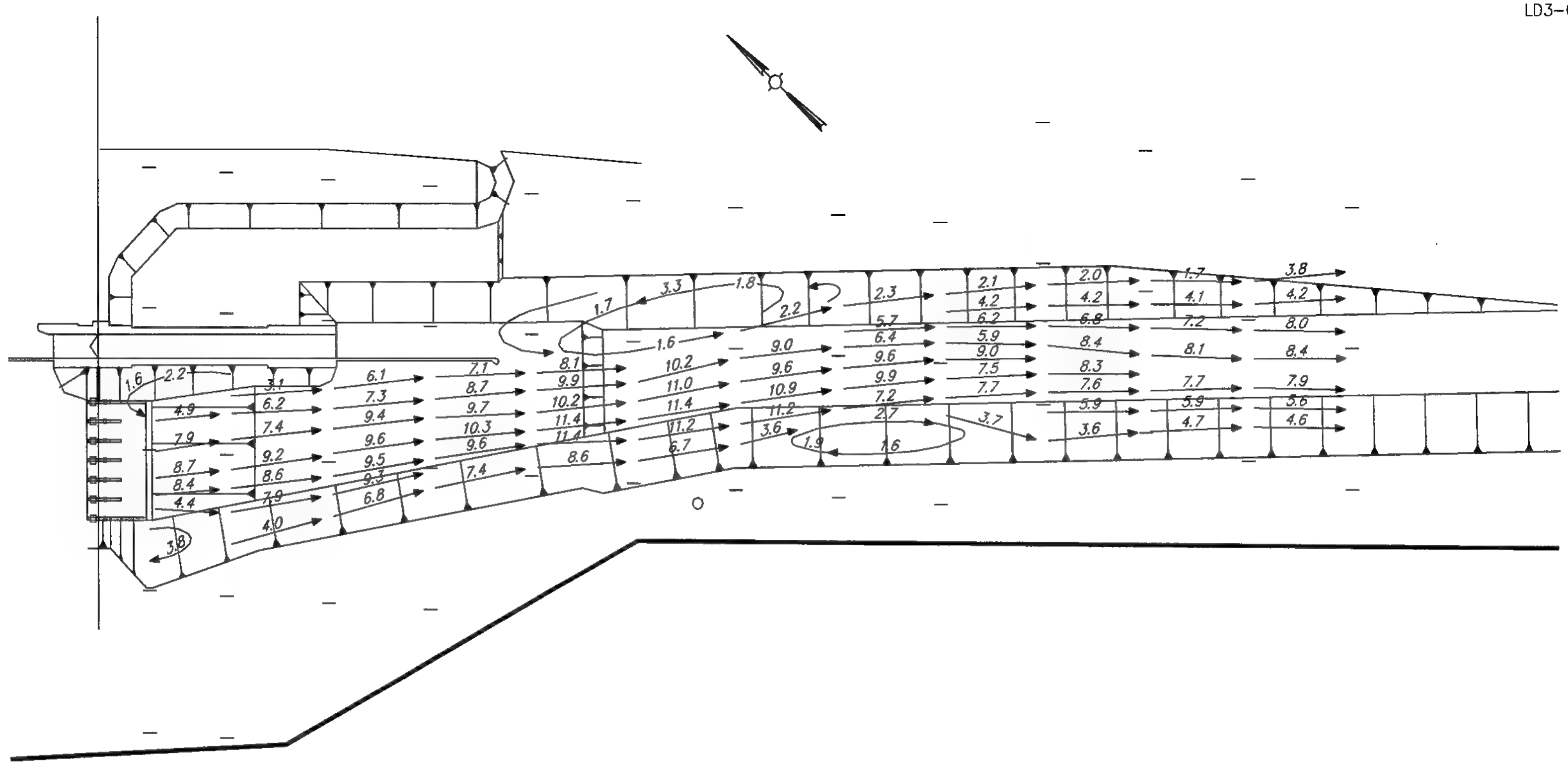


VELOCITIES AND CURRENT DIRECTIONS

PLAN H WITHOUT DIKE

DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT

LD3-028



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

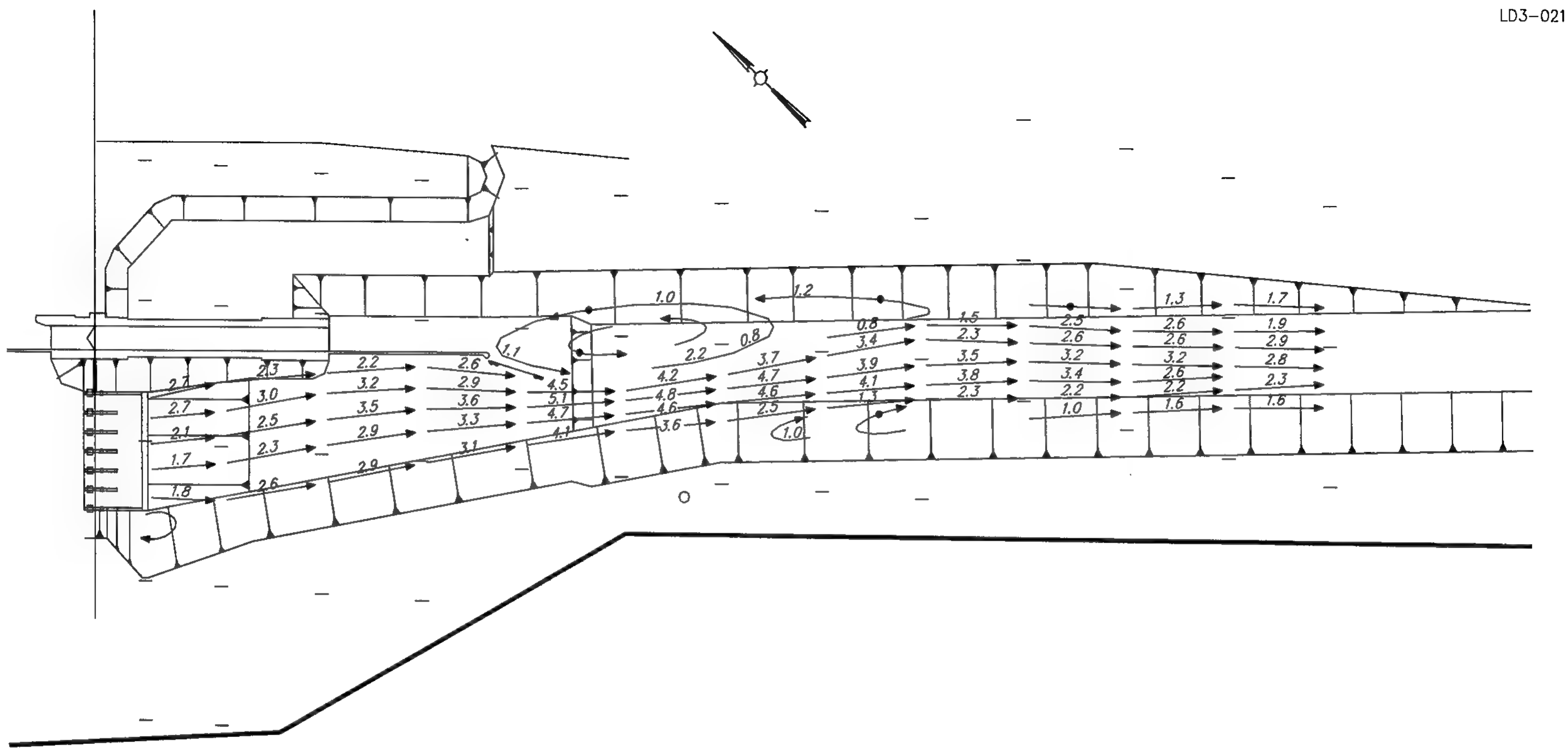
PROTOTYPE 500 0 500 1000 1500

MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H WITHOUT DIKE

DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- →•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- —·— NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

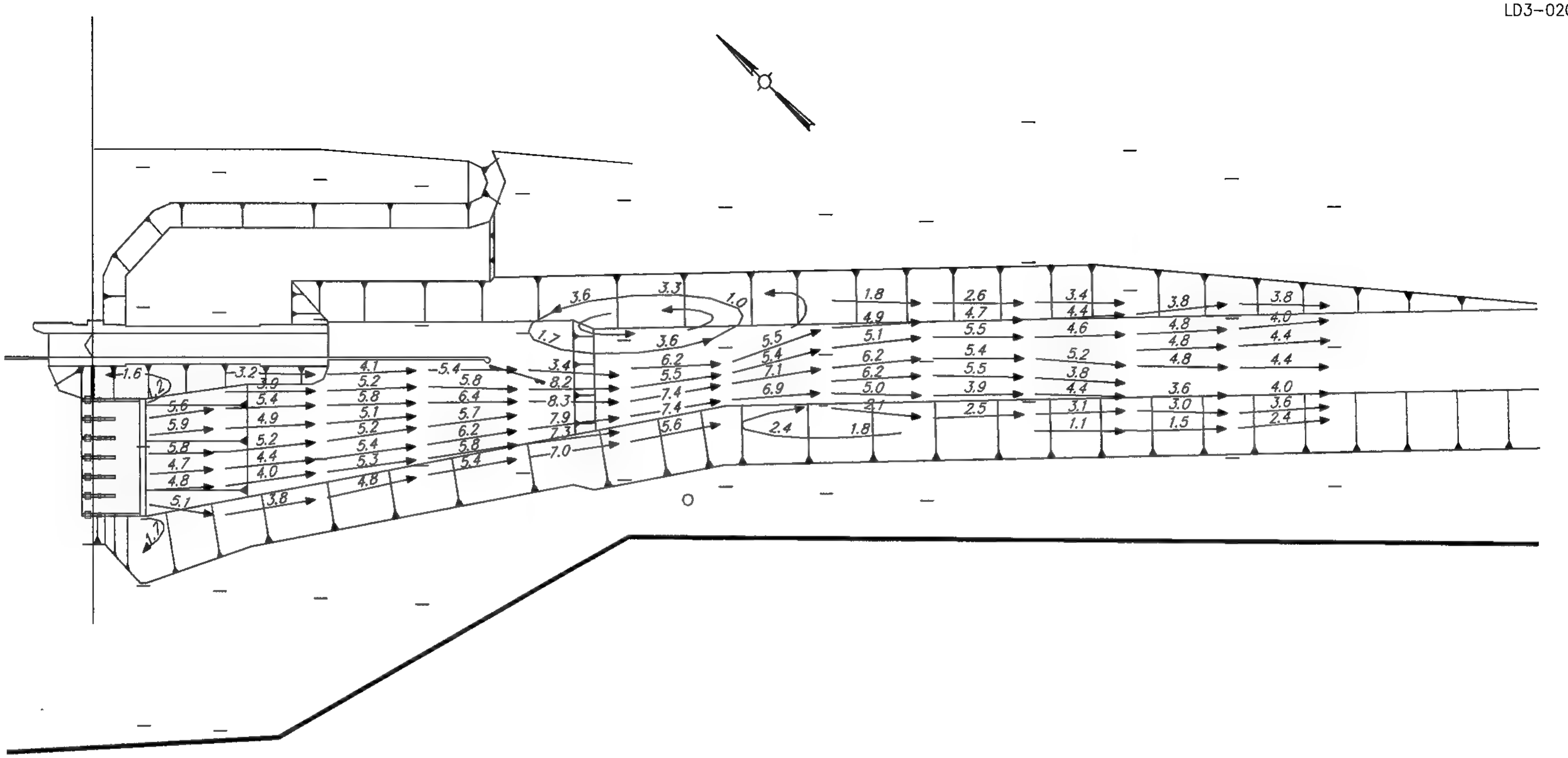
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H - WITH DIKE

DISCHARGE: 20,000 CFS
TAILWATER EL: 70.1 FT

LD3-020



LEGEND

3.2 → VELOCITY IN FEET PER SECOND
—•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
— - — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

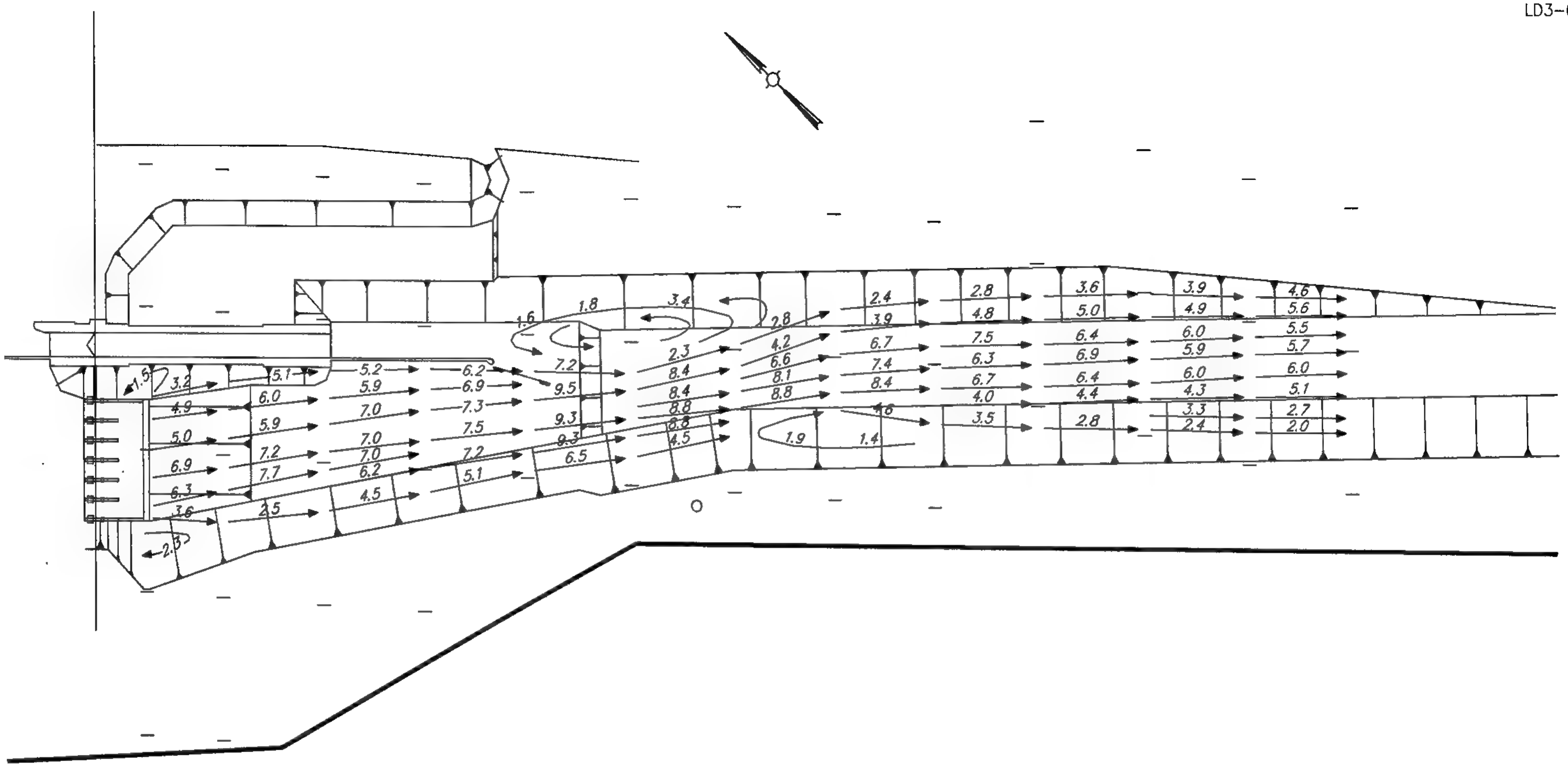
PROTOTYPE 500 0 500 1000 1500

MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H - WITH DIKE

DISCHARGE: 60,000 CFS
TAILWATER EL: 79.8 FT



LD3-019

LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- → VELOCITY LESS THAN 0.5 FEET PER SECOND
- — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

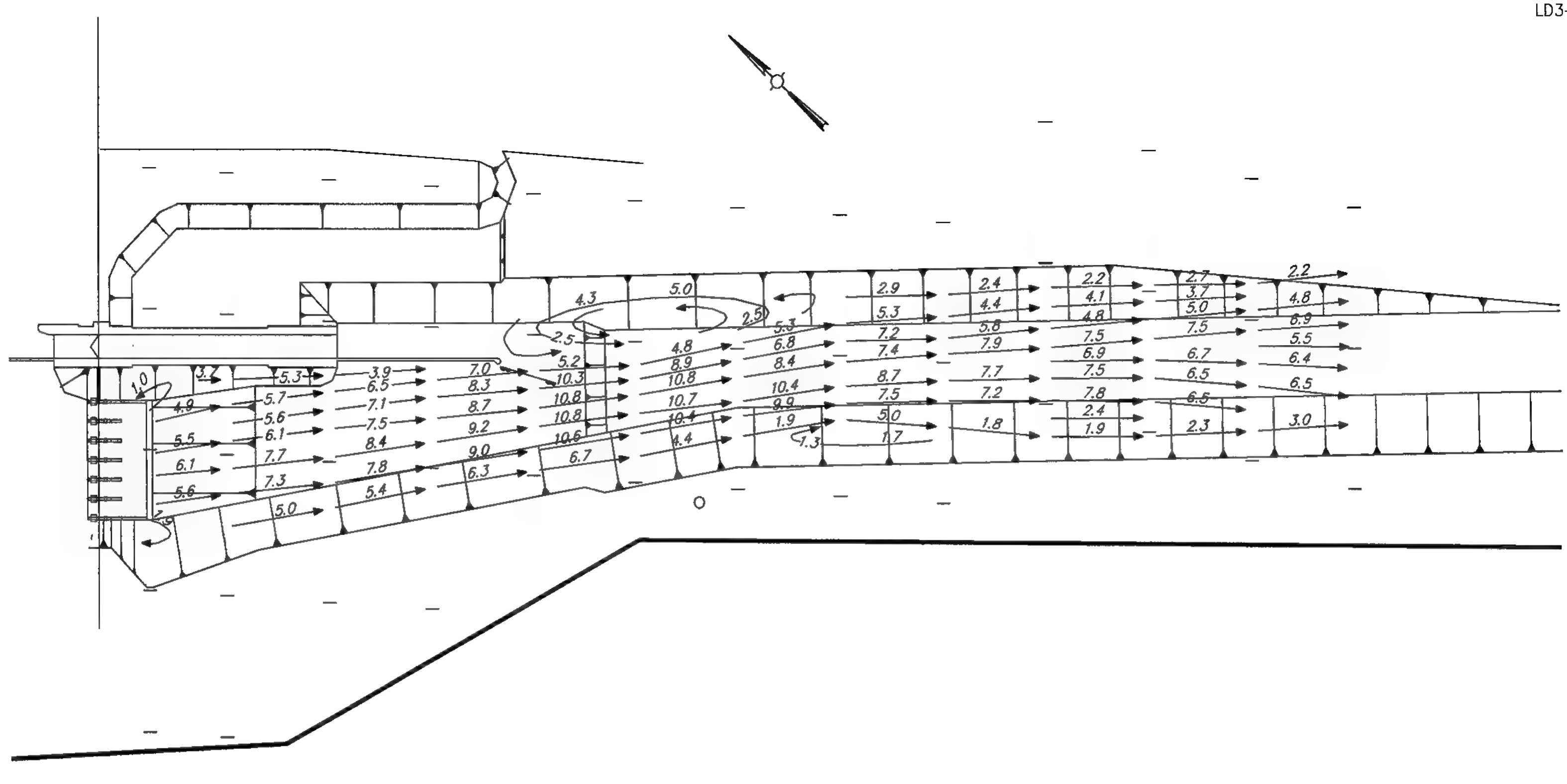
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H - WITH DIKE

DISCHARGE: 80,000 CFS
TAILWATER EL: 83.0 FT

LD3-018



LEGEND

3.2 → VELOCITY IN FEET PER SECOND
—•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
—·— NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

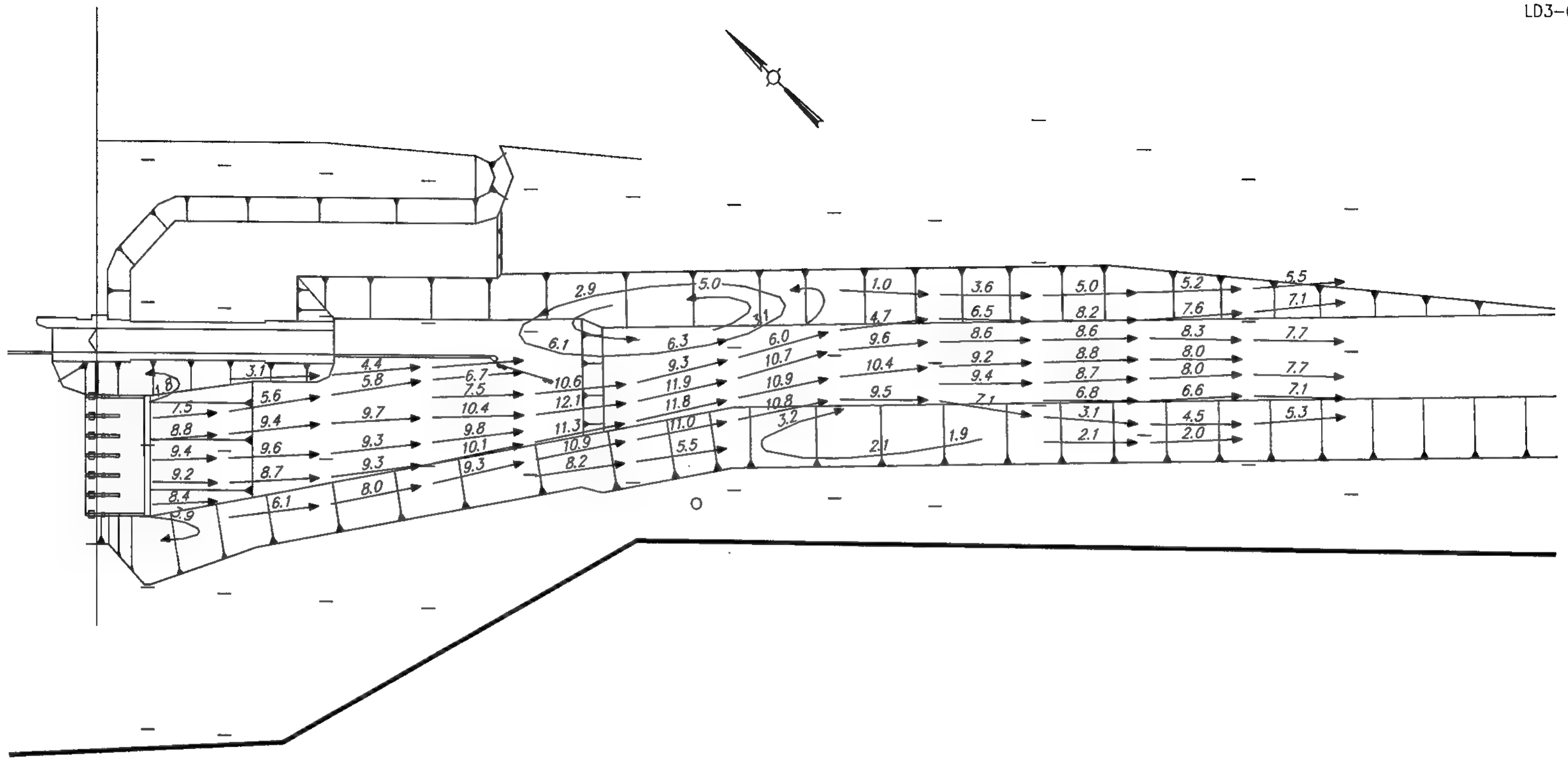
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H - WITH DIKE

DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT

LD3-017



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- —•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- - - — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

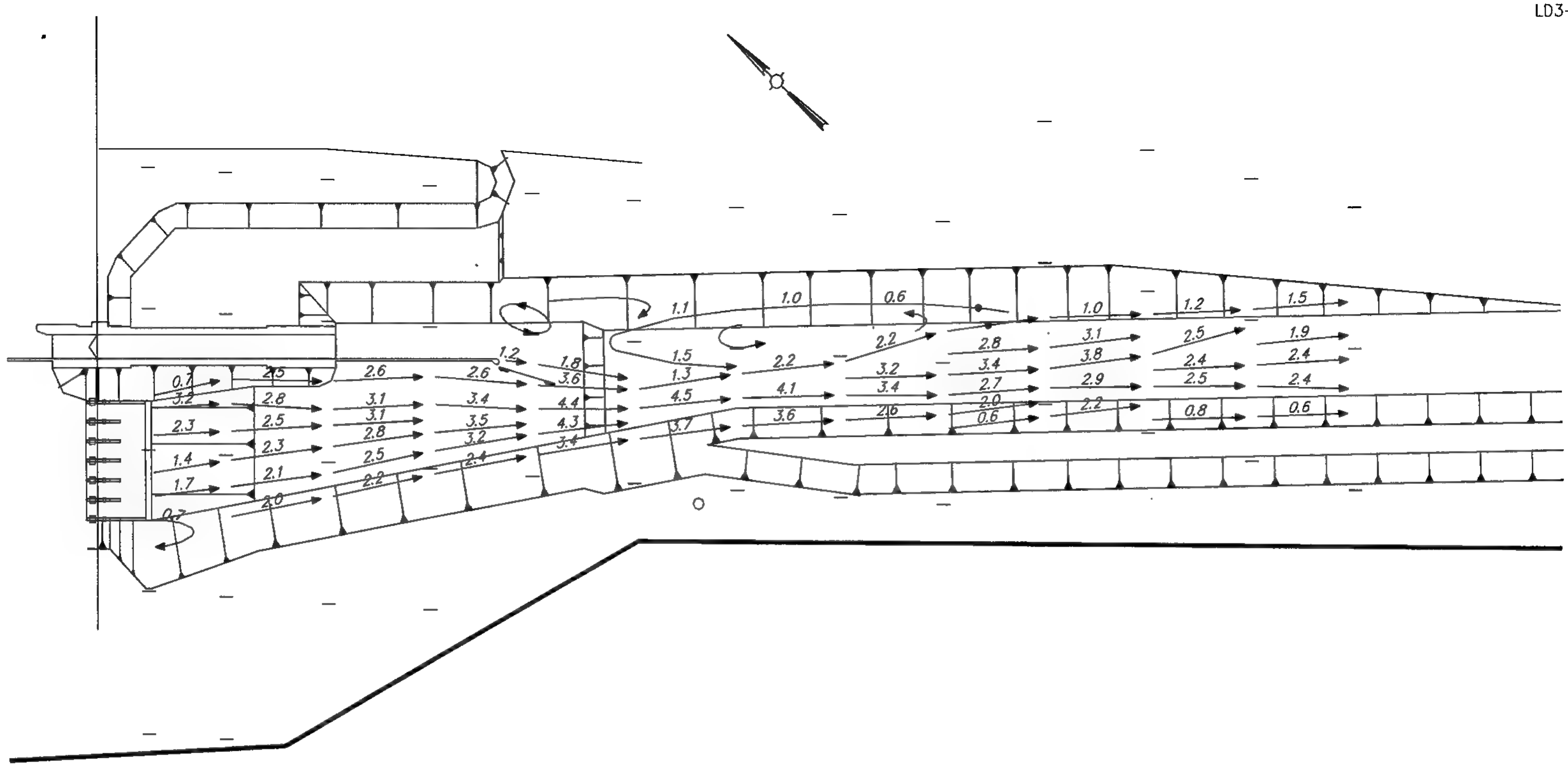
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H - WITH DIKE

DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT

LD3-012



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

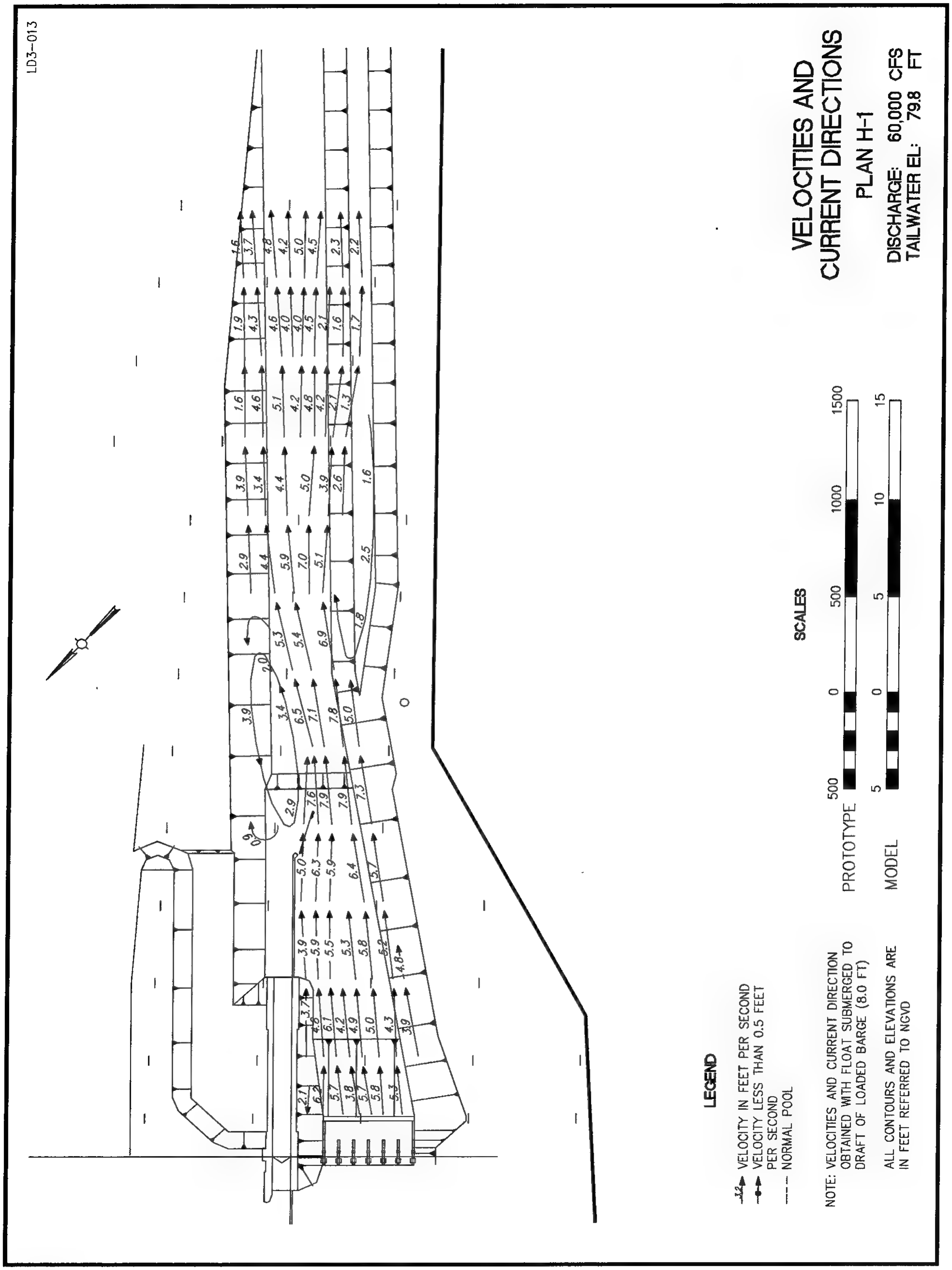
PROTOTYPE 500 0 500 1000 1500

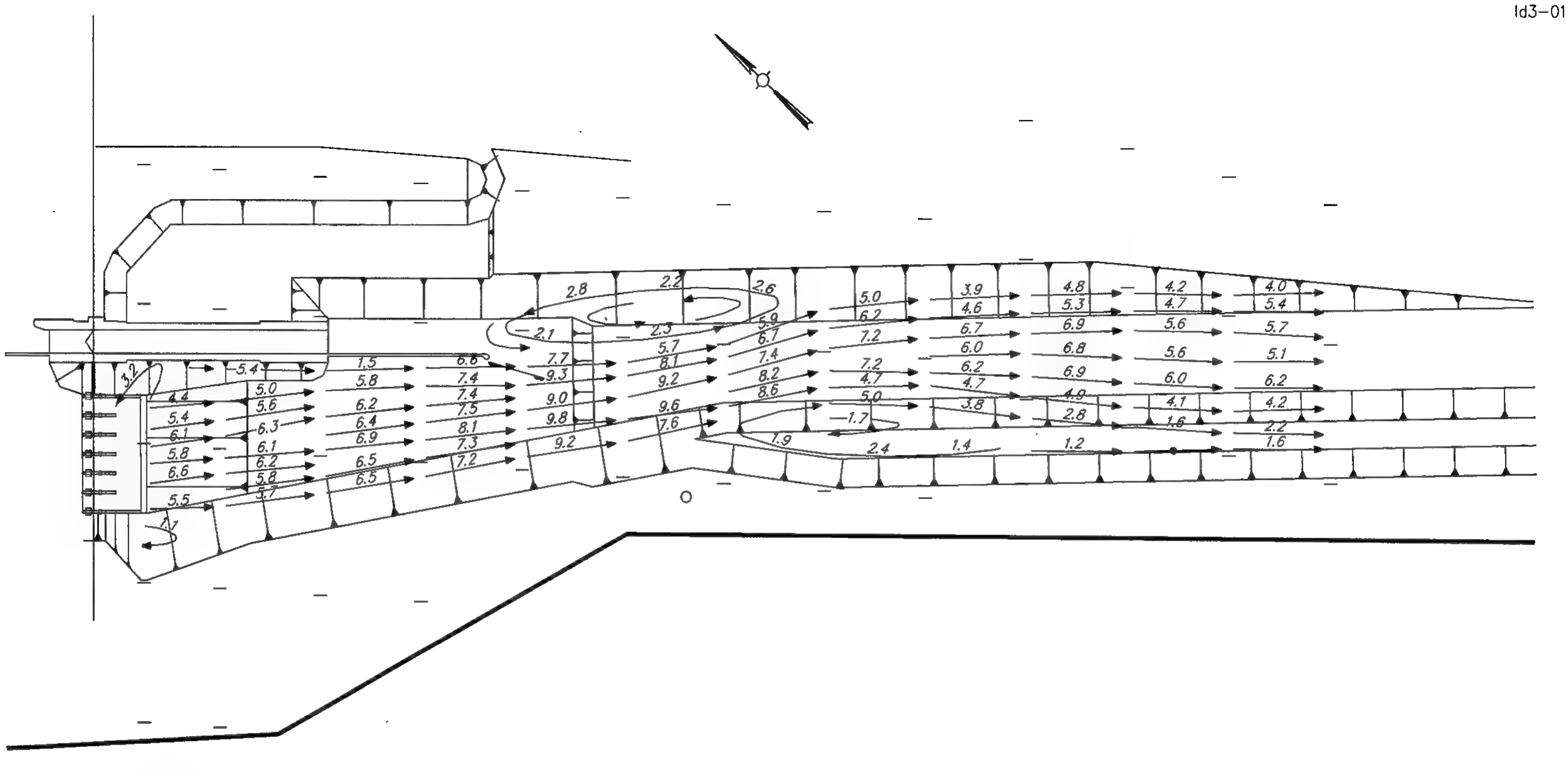
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-1

DISCHARGE: 20,000 CFS
TAILWATER EL: 70.2 FT


LD3-013
VELOCITIES AND CURRENT DIRECTIONS
PLAN H-1
DISCHARGE: 60,000 CFS
TAILWATER EL: 79.8 FT
SCALES
PROTOTYPE
500 0 500 1000 1500
MODEL
5 0 5 10 15
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- →•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- – – – NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

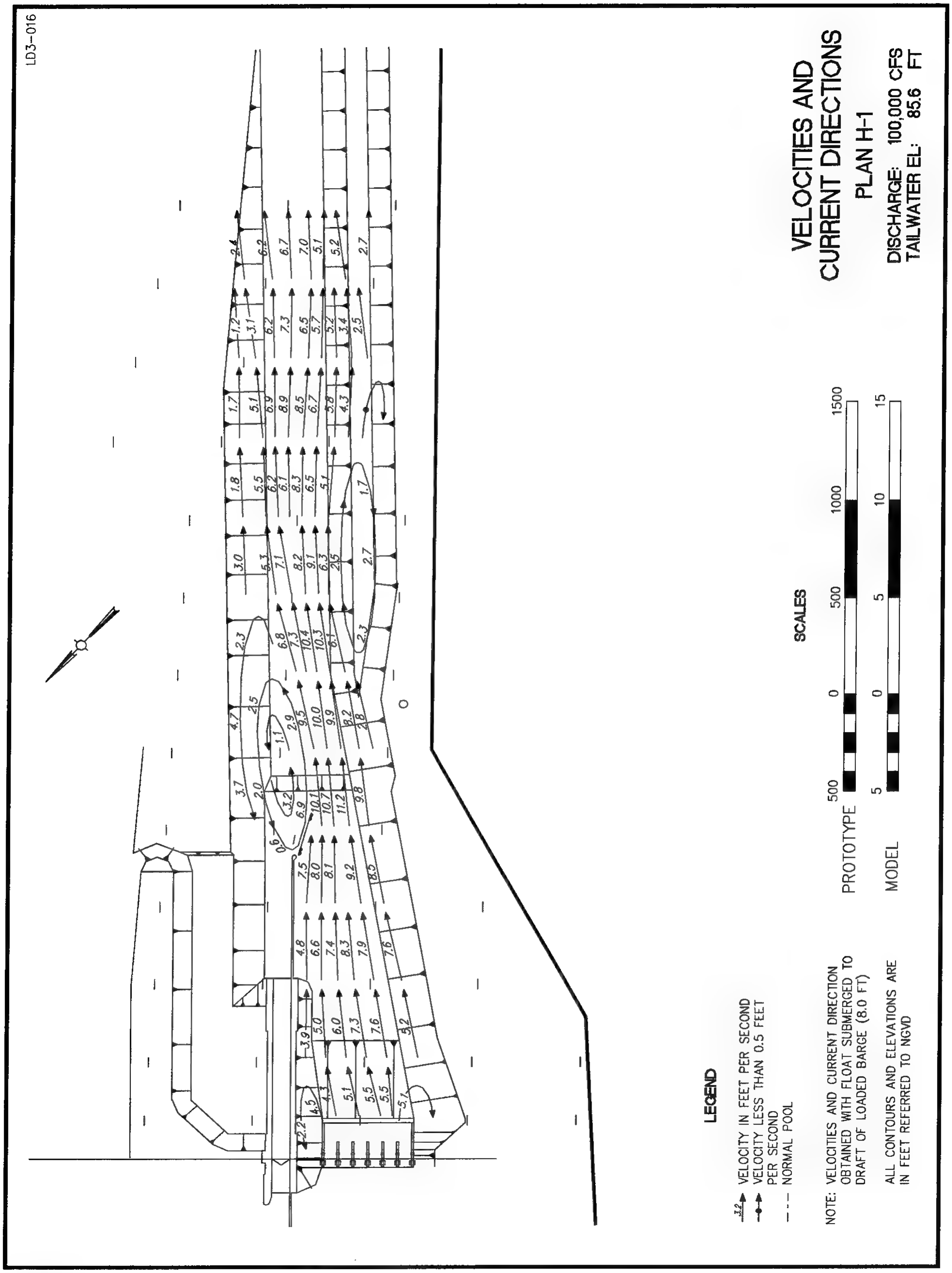
PROTOTYPE 500 0 500 1000 1500

MODEL 5 0 5 10 15

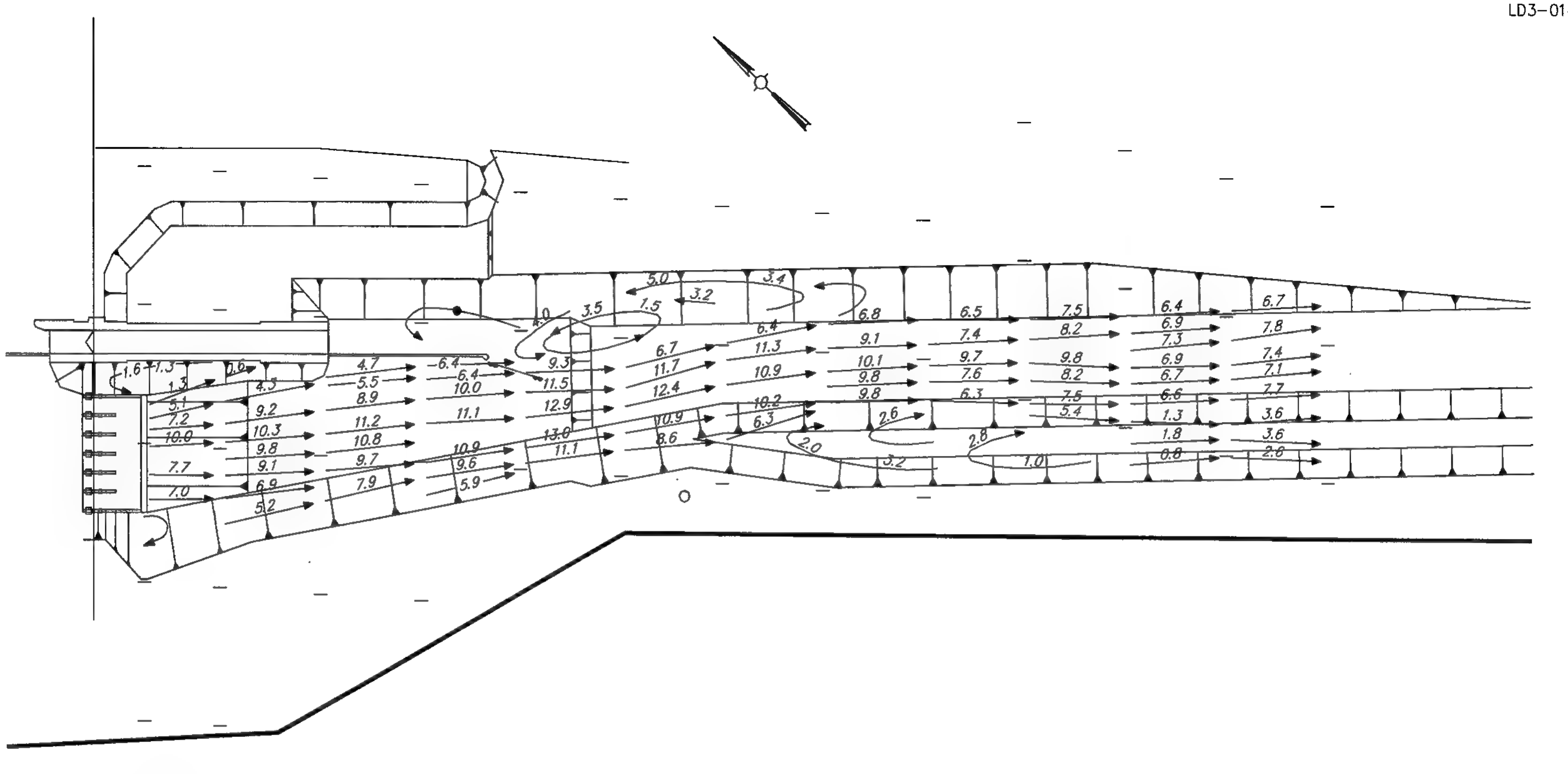
VELOCITIES AND CURRENT DIRECTIONS

PLAN H-1

DISCHARGE: 80,000 CFS
TAILWATER EL: 83.0 FT


LD3-016
VELOCITIES AND CURRENT DIRECTIONS
PLAN H-1
DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT
SCALES
PROTOTYPE 500 0 500 1000 1500
MODEL 5 0 5 10 15
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

LD3-014



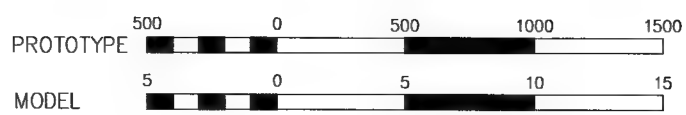
LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- —•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- - - - NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES



VELOCITIES AND CURRENT DIRECTIONS

PLAN H-1

DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT

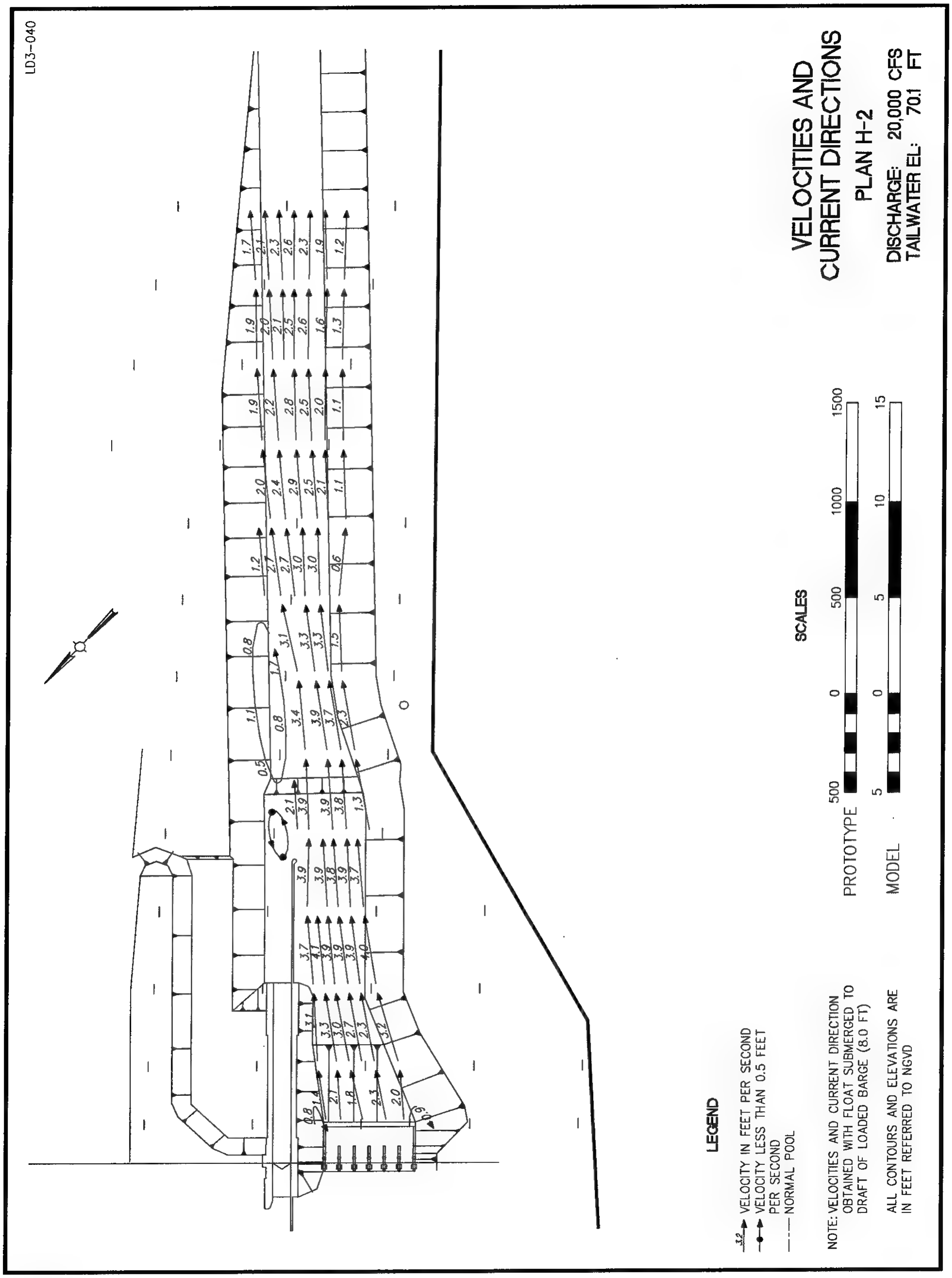
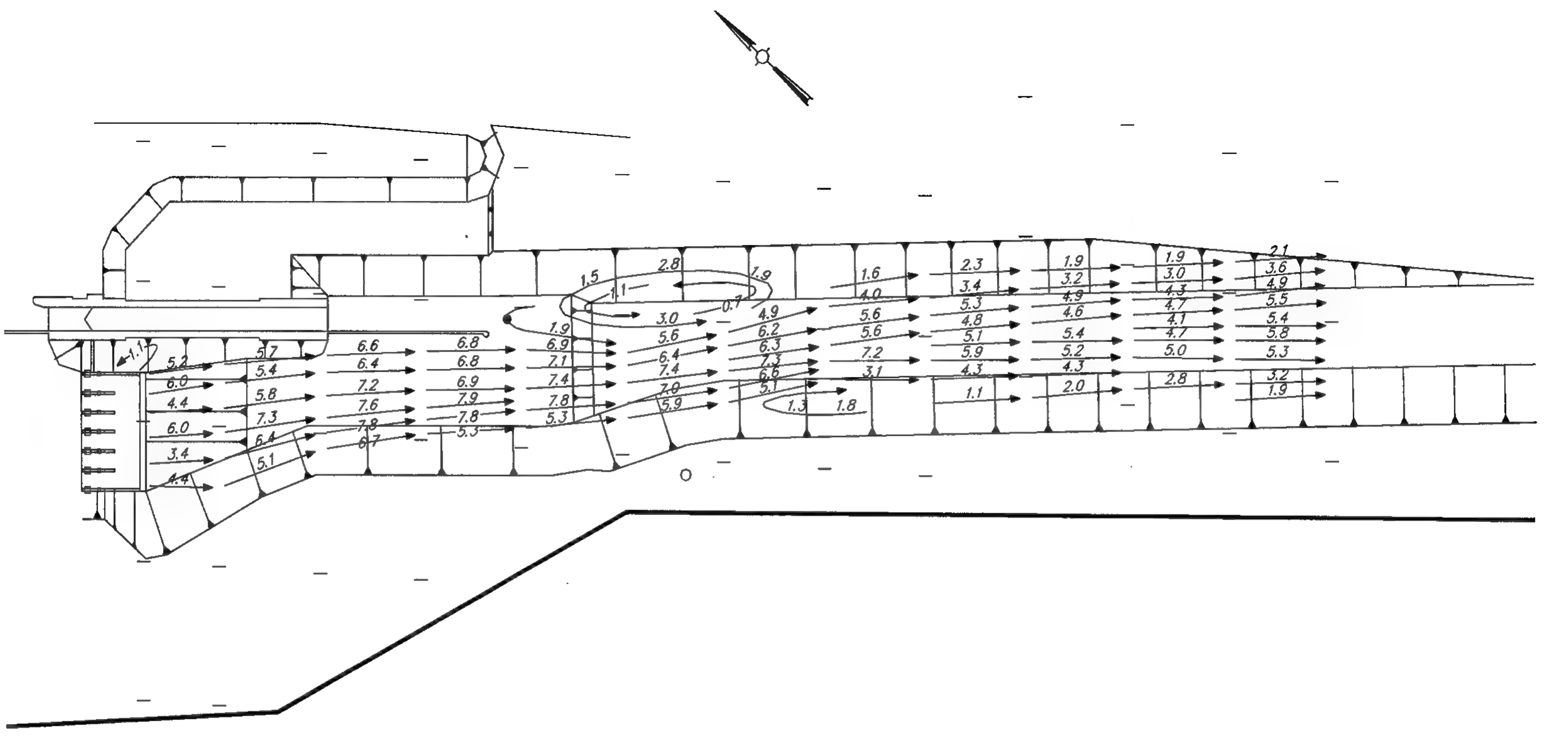

LD3-040
VELOCITIES AND CURRENT DIRECTIONS
PLAN H-2
DISCHARGE: 20,000 CFS
TAILWATER EL: 70.1 FT
SCALES
PROTOTYPE
MODEL
500 0 500 1000 1500
5 0 5 10 15
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

Plate 72



LEGEND

3.2 → VELOCITY IN FEET PER SECOND
→ VELOCITY LESS THAN 0.5 FEET PER SECOND
— - — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

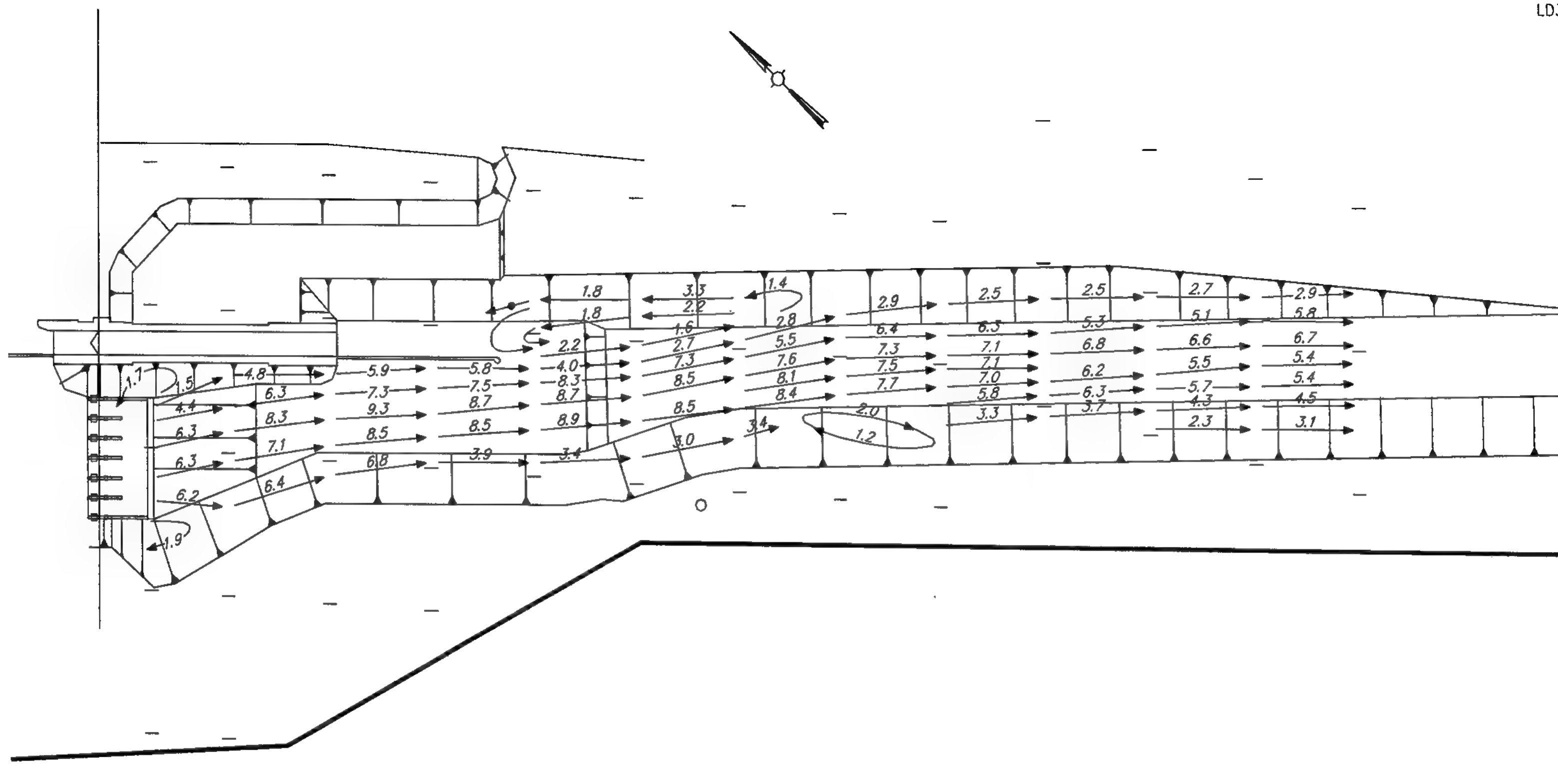
PROTOTYPE 500 0 500 1000 1500

MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-2

DISCHARGE: 60,000 CFS
TAILWATER EL: 79.8 FT



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- —•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- ---- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

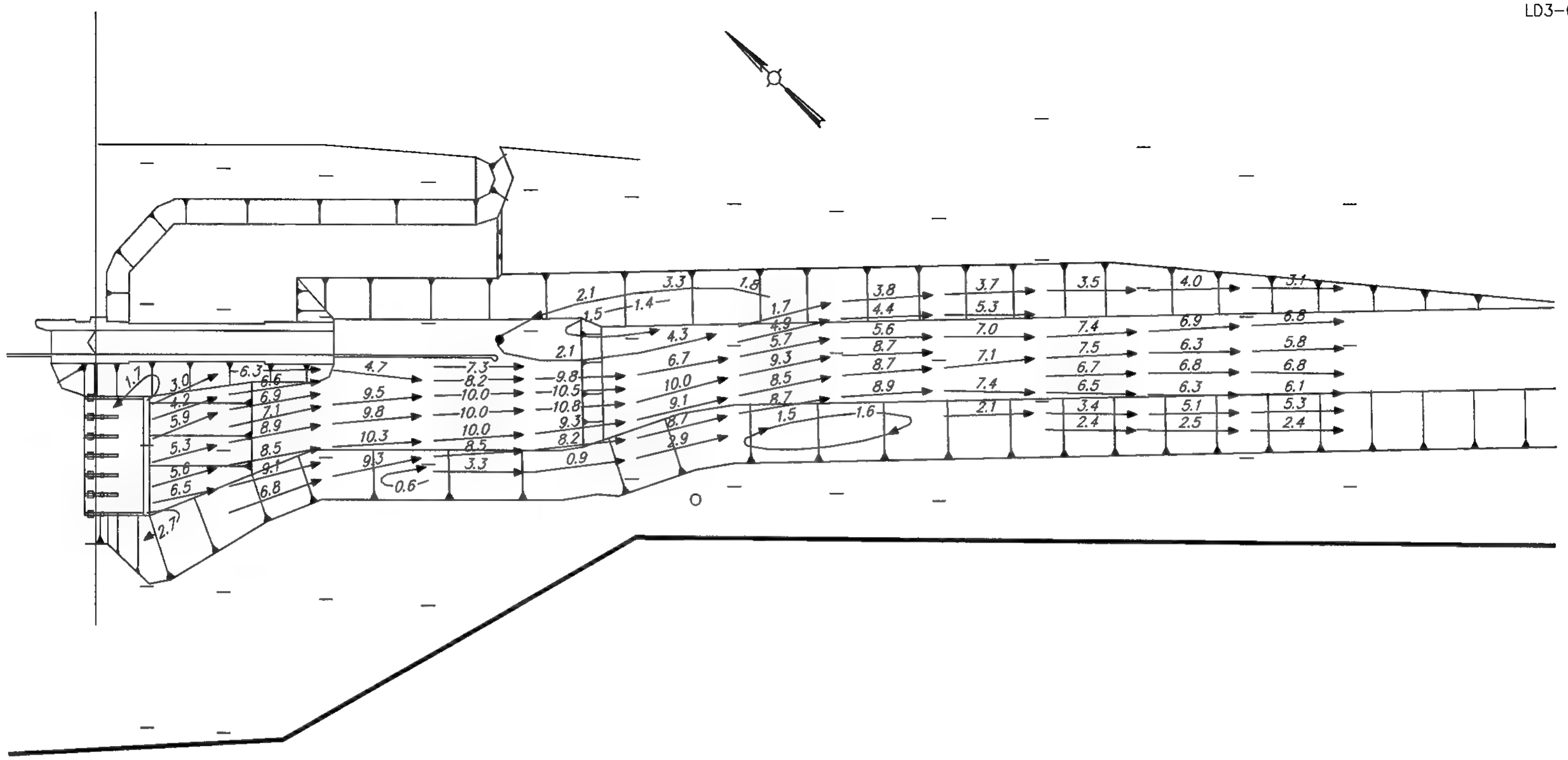
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-2

DISCHARGE: 80,000 CFS
TAILWATER EL: 83.0 FT

LD3-038



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- → VELOCITY LESS THAN 0.5 FEET PER SECOND
- — — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

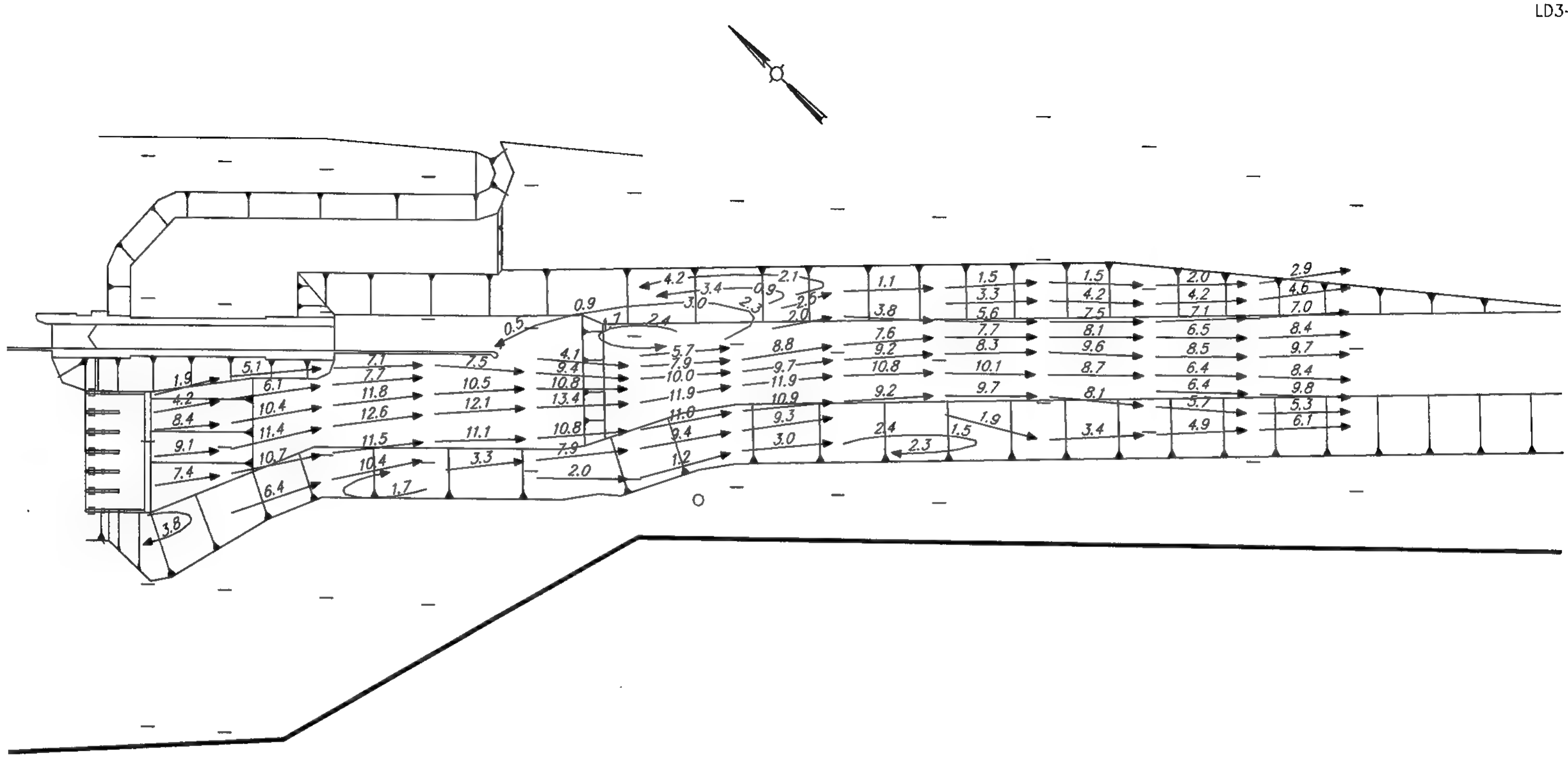
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-2

DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT

LD3-035



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- →•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- — - — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

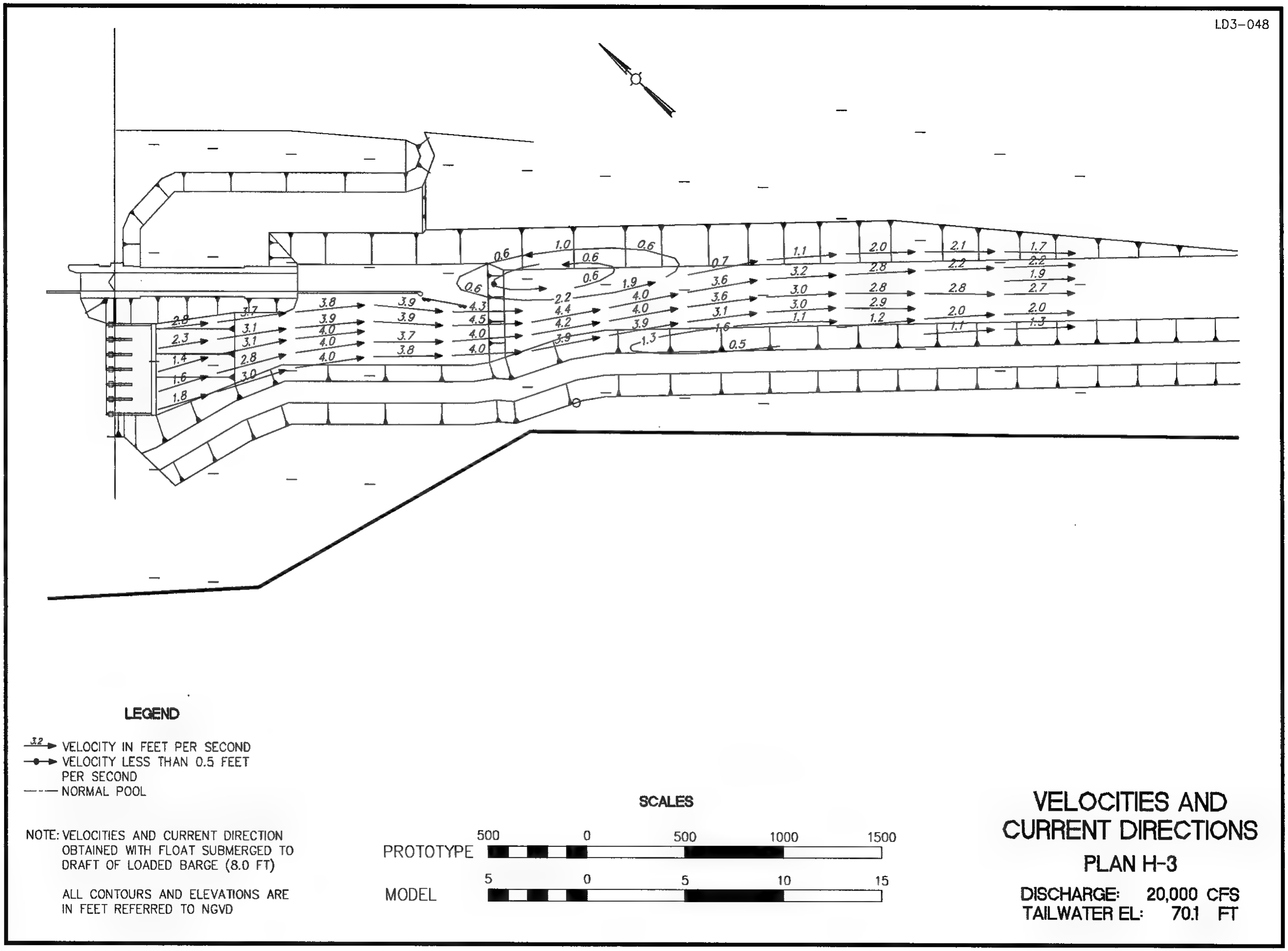
PROTOTYPE 500 0 500 1000 1500

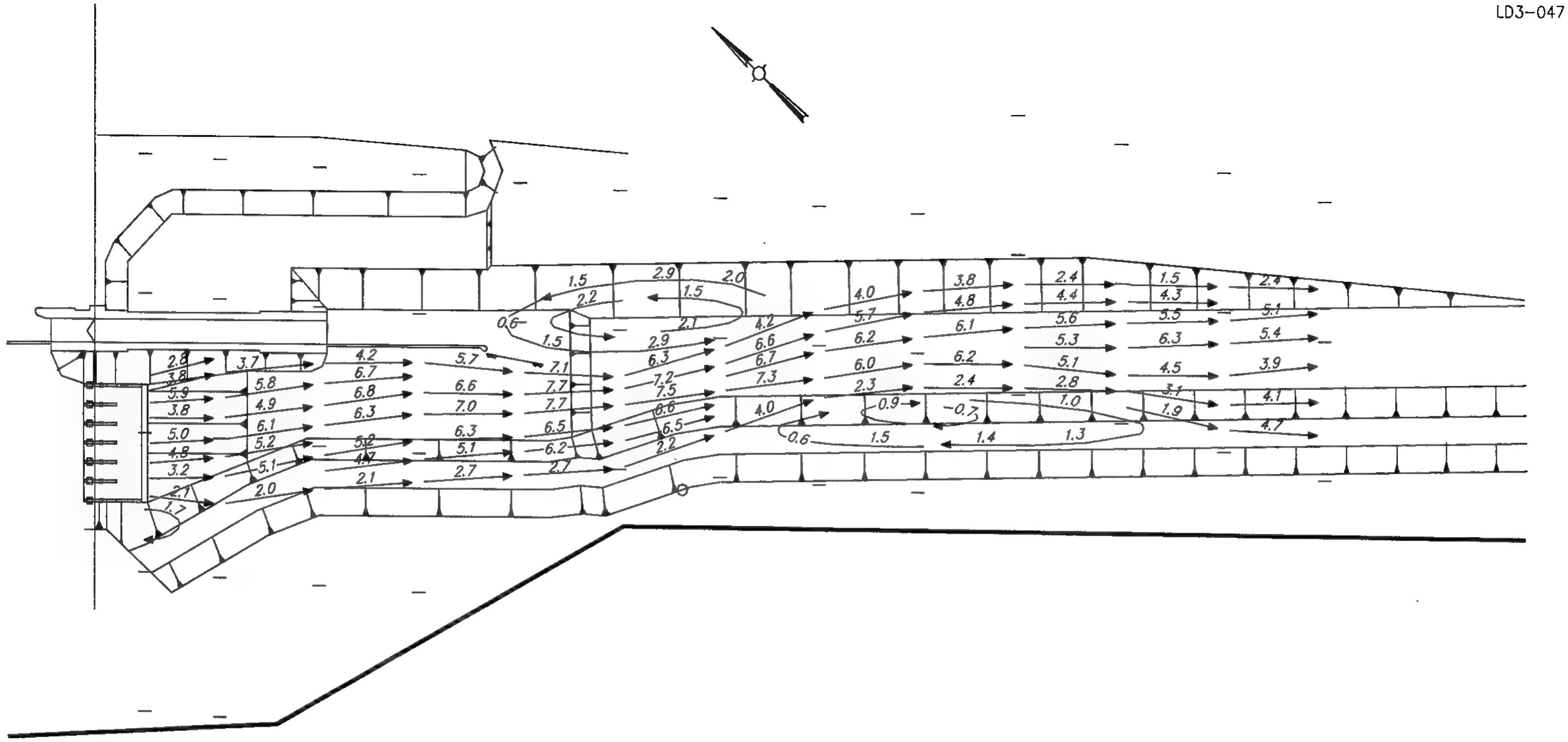
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-2

DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT


LD3-048
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SCALES
PROTOTYPE 500 0 500 1000 1500
MODEL 5 0 5 10 15
VELOCITIES AND CURRENT DIRECTIONS
PLAN H-3
DISCHARGE: 20,000 CFS
TAILWATER EL: 70.1 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

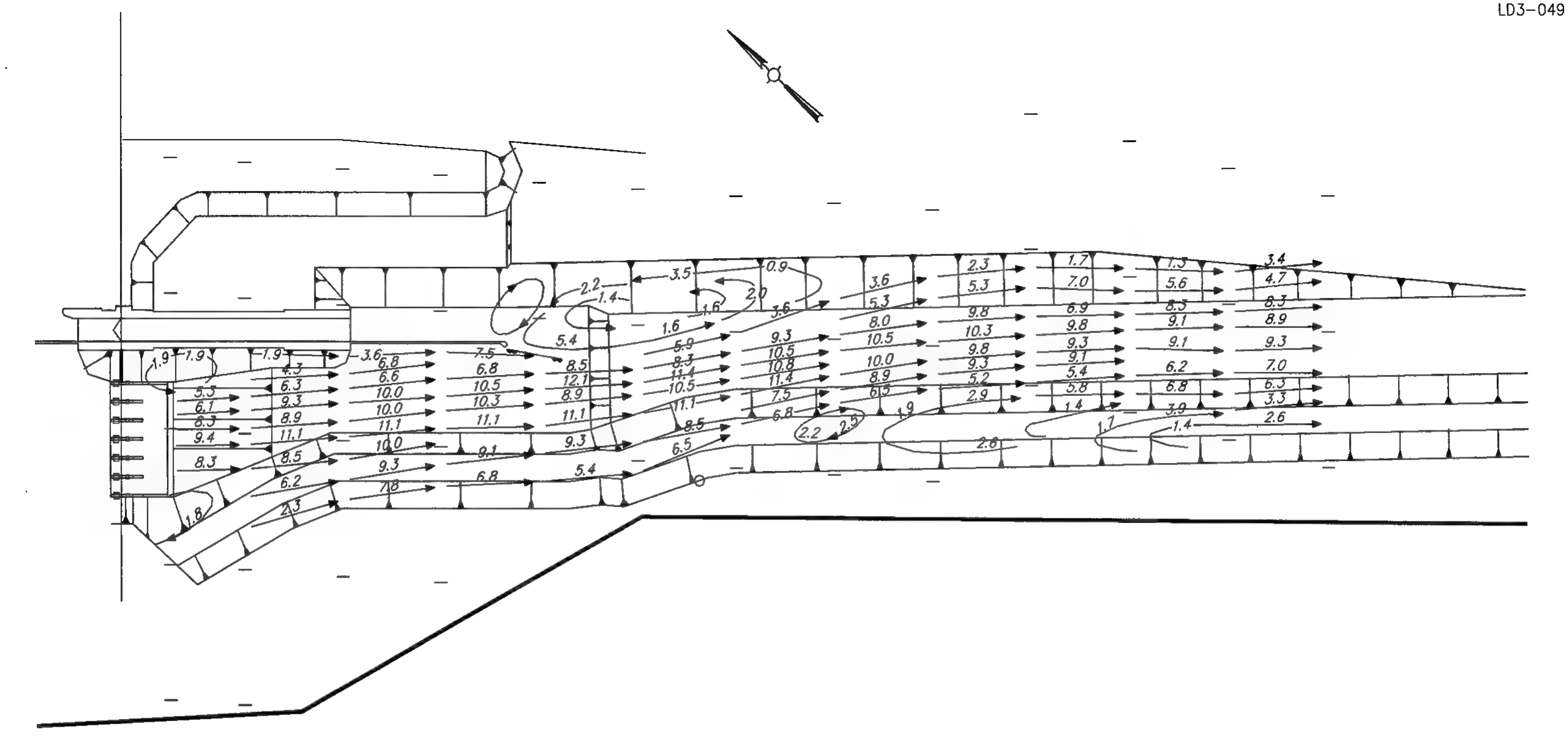
PROTOTYPE 500 0 500 1000 1500

MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-3

DISCHARGE: 60,000 CFS
TAILWATER EL: 79.8 FT



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- → VELOCITY LESS THAN 0.5 FEET PER SECOND
- — · — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

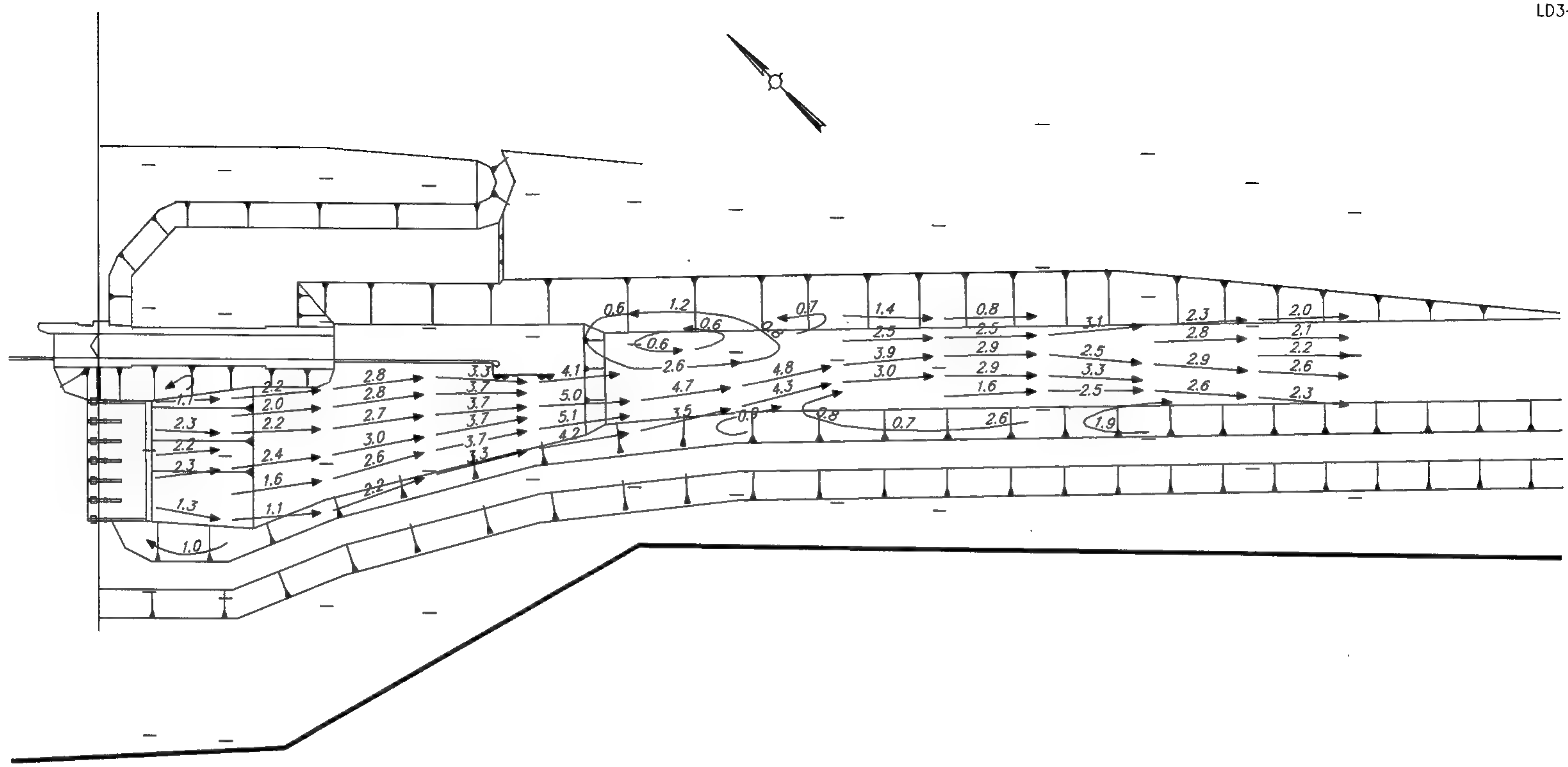
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-3

DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT

LD3-054



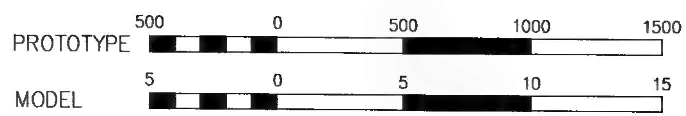
LEGEND

3.2 → VELOCITY IN FEET PER SECOND
→ VELOCITY LESS THAN 0.5 FEET PER SECOND
— - — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

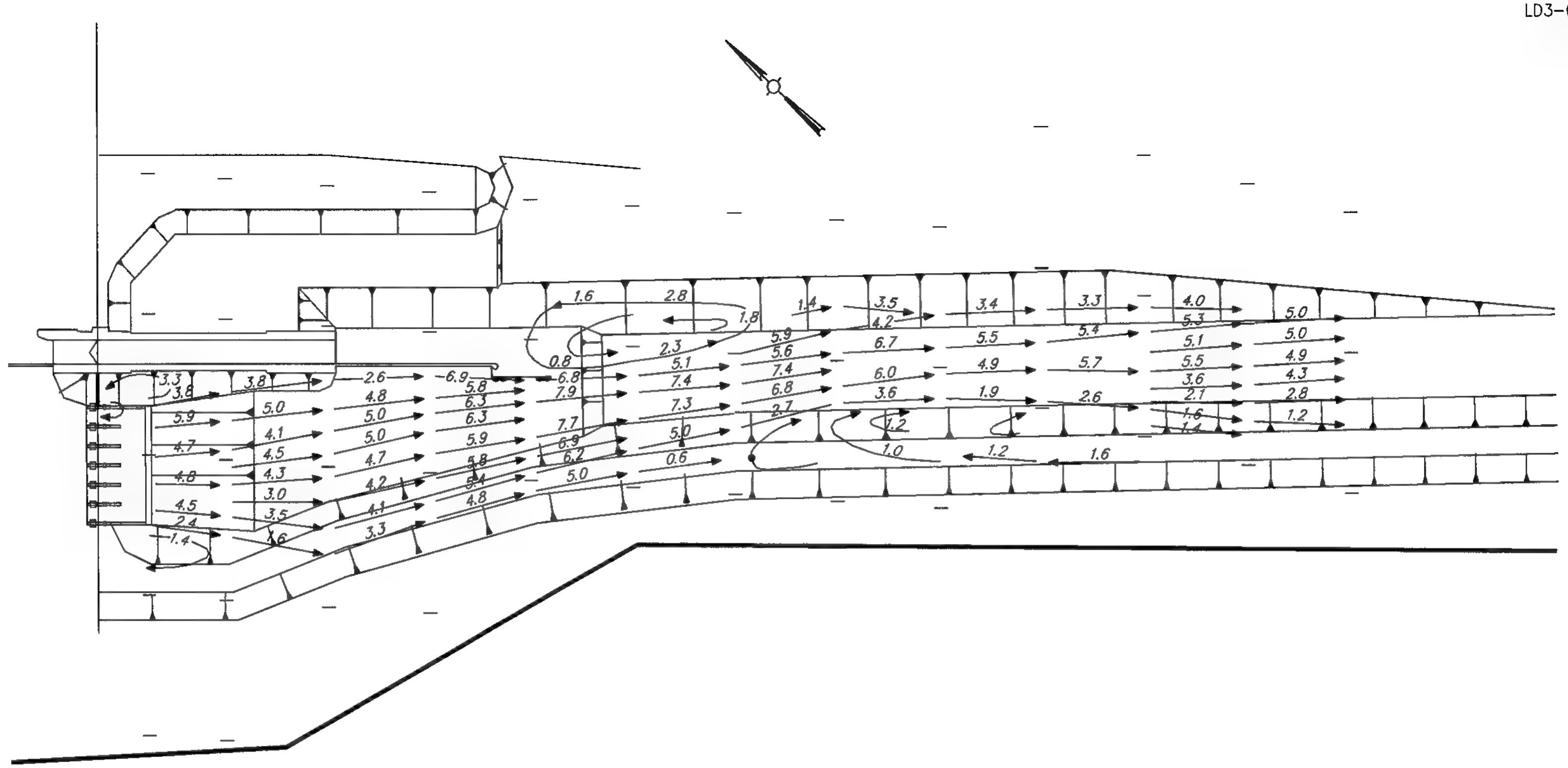


VELOCITIES AND CURRENT DIRECTIONS

PLAN H-4

DISCHARGE: 20,000 CFS
TAILWATER EL: 70.1 FT

LD3-053



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- —•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- —·— NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

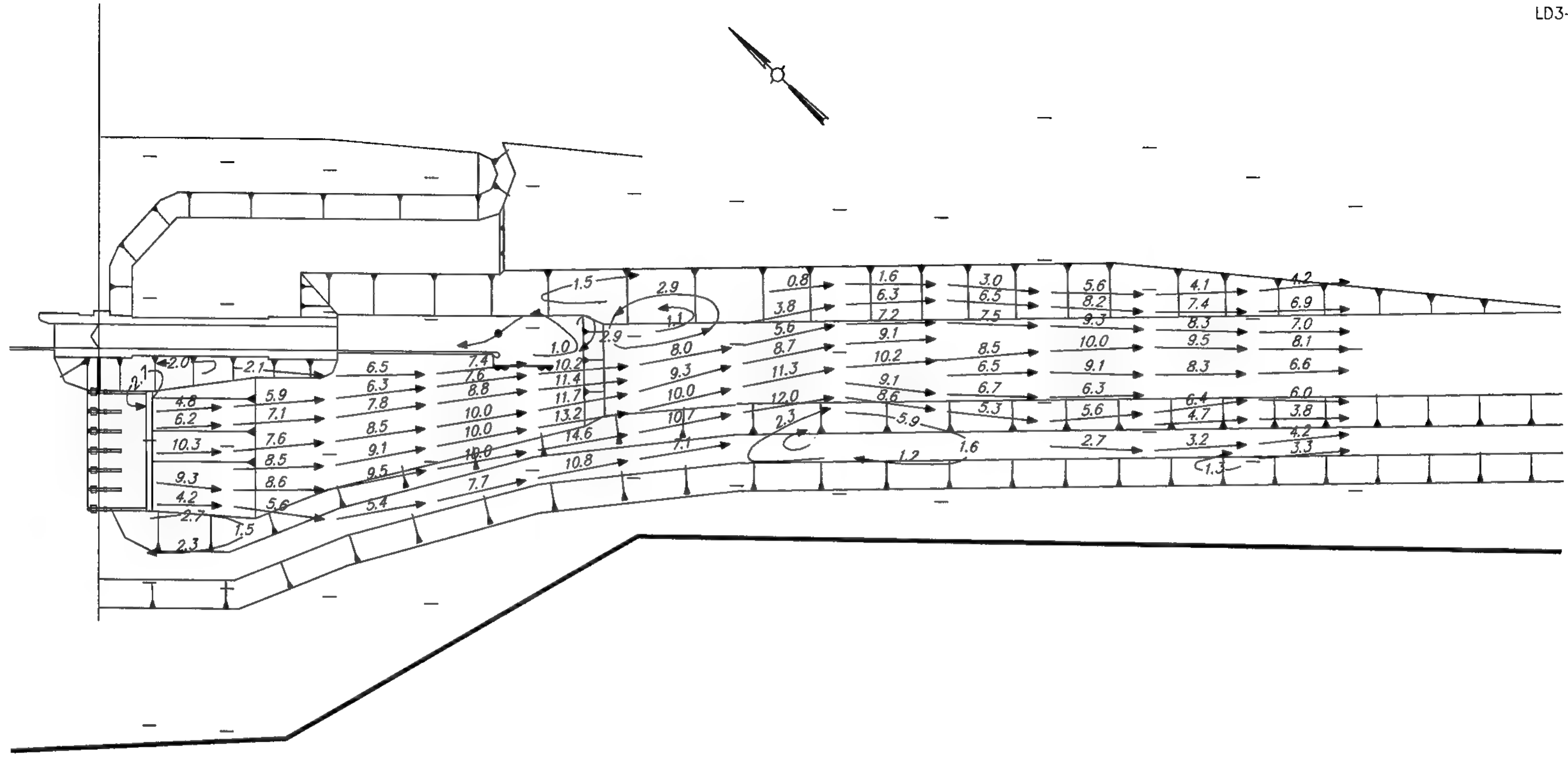
PROTOTYPE 500 0 500 1000 1500

MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-4

DISCHARGE: 60,000 CFS
TAILWATER EL: 79.8 FT



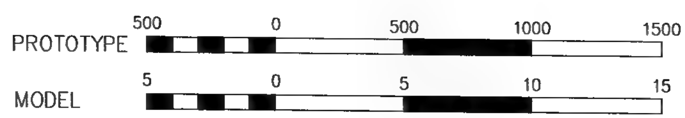
LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

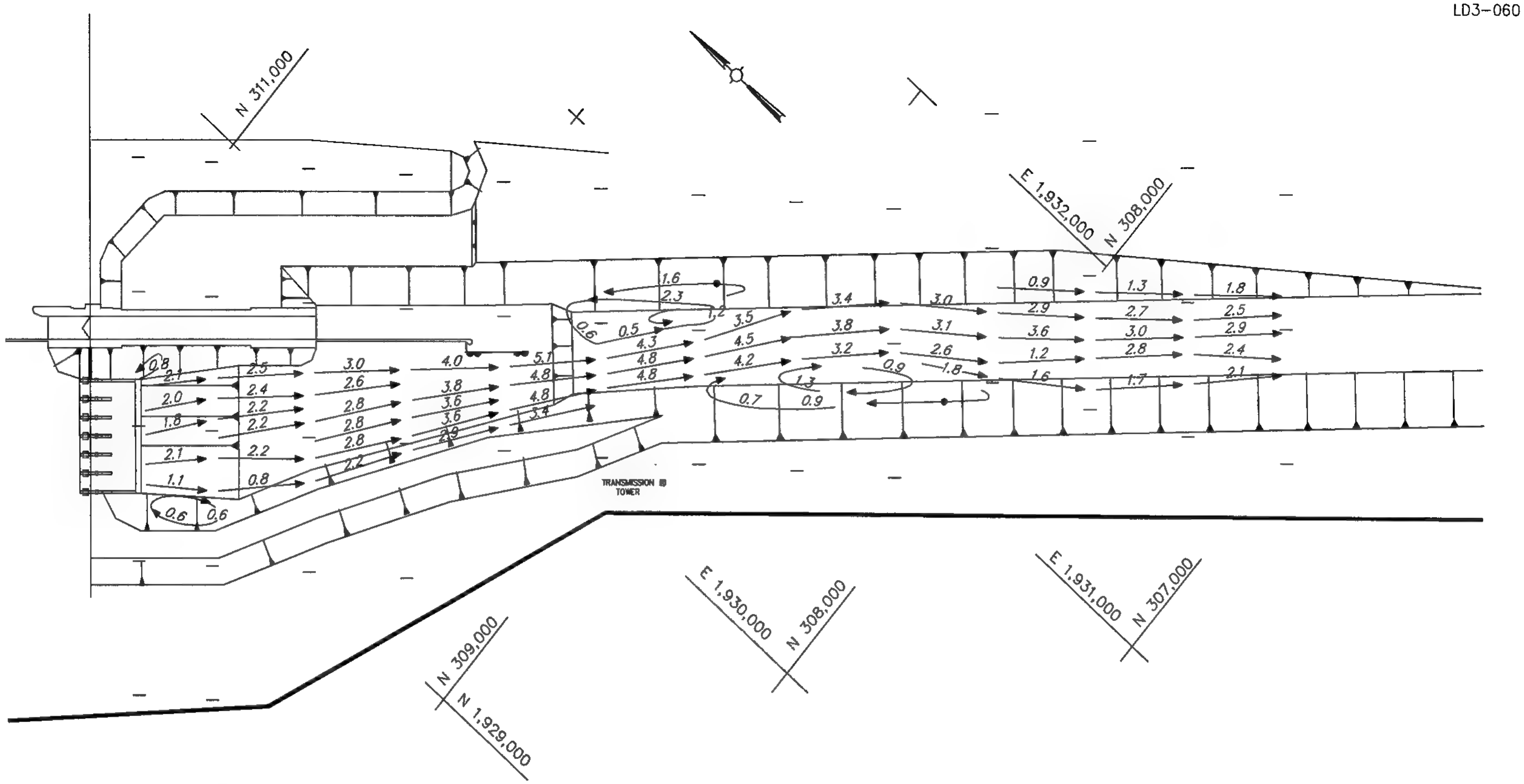


VELOCITIES AND CURRENT DIRECTIONS

PLAN H-4

DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT

LD3-060



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- → VELOCITY LESS THAN 0.5 FEET PER SECOND
- —·— NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

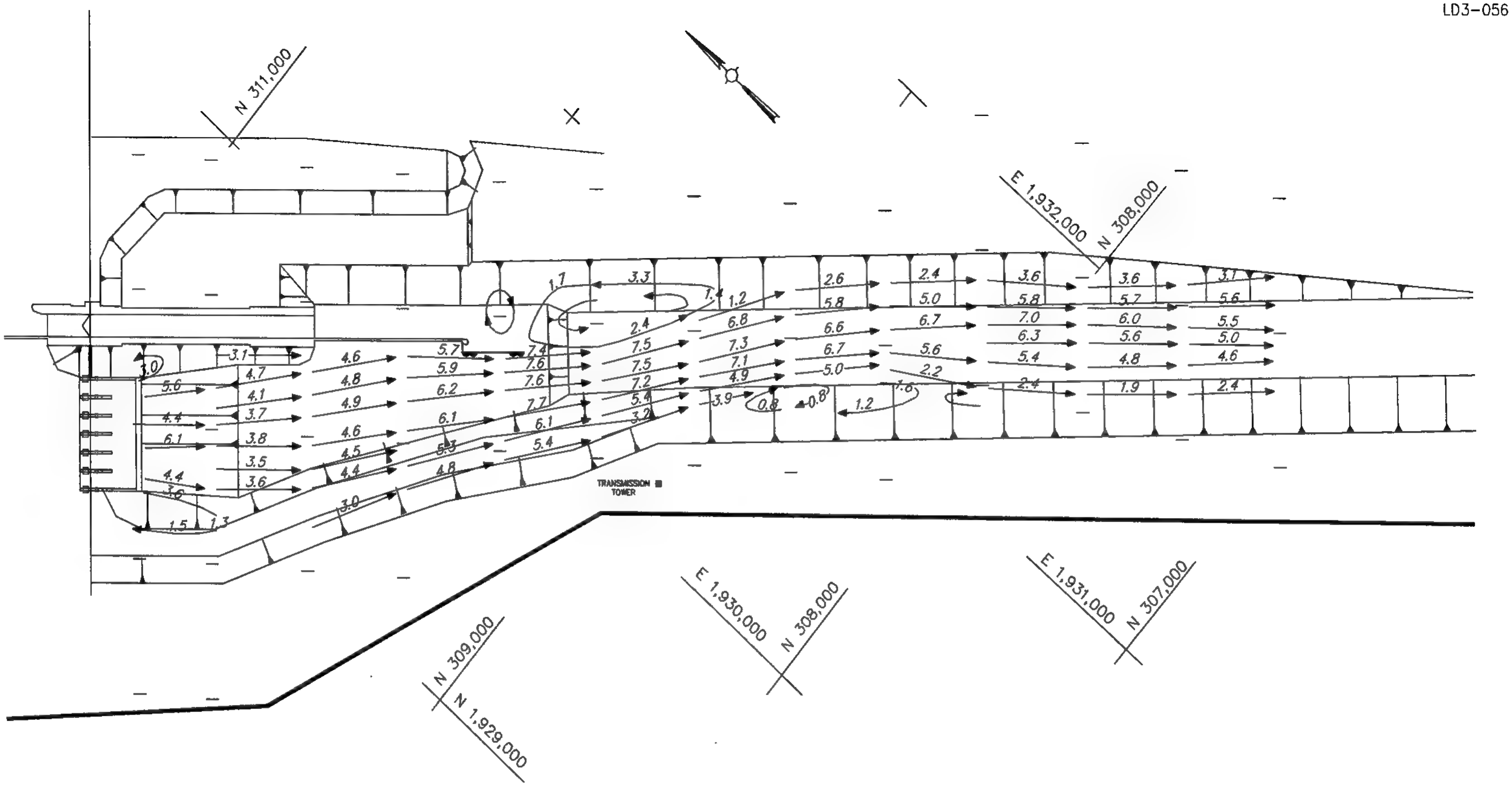
PROTOTYPE 500 0 500 1000 1500

MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-5

DISCHARGE: 20,000 CFS
TAILWATER EL: 70.1 FT



LEGEND

3.2 → VELOCITY IN FEET PER SECOND
•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
— - — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

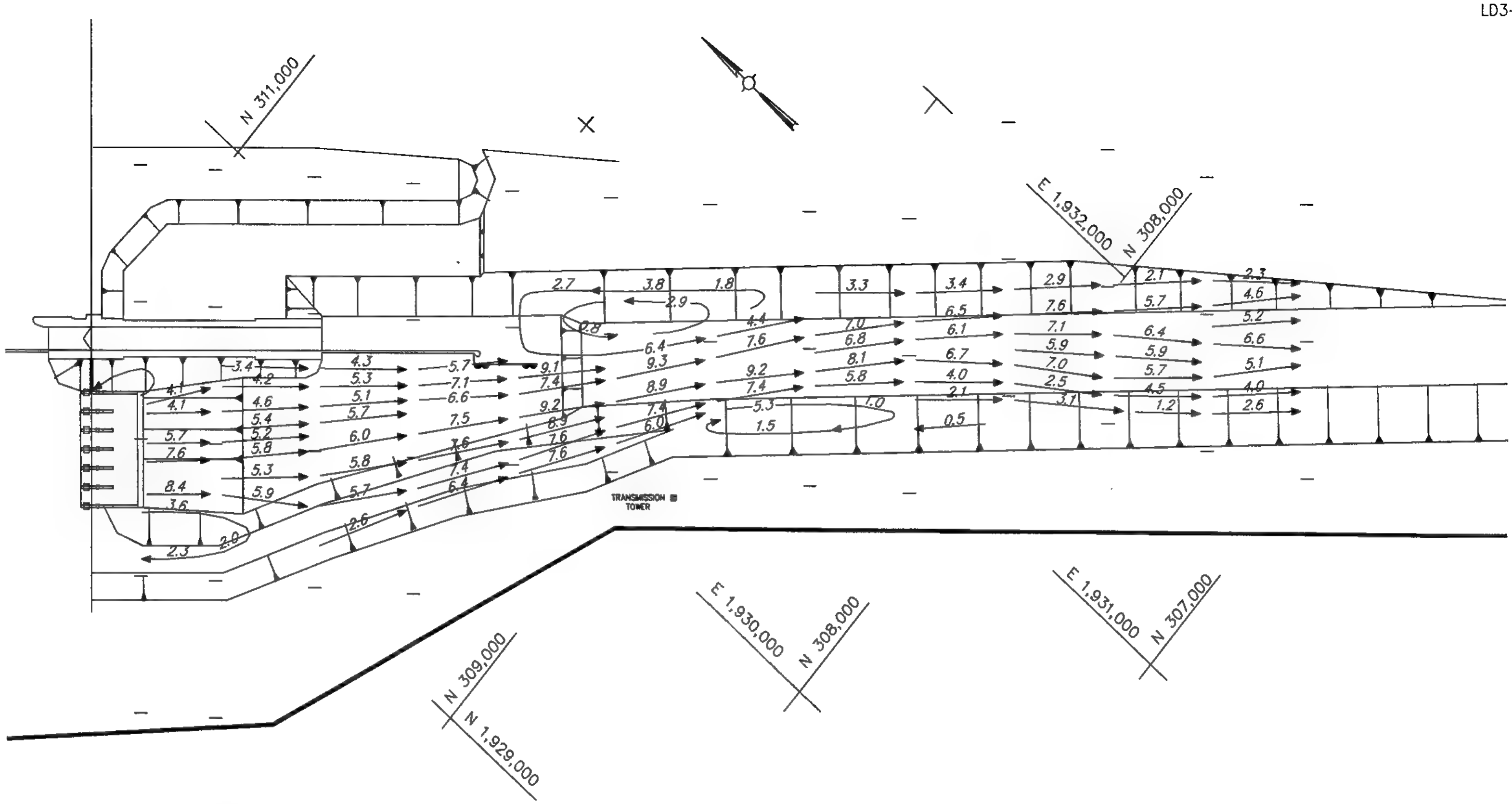
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-5

DISCHARGE: 60,000 CFS
TAILWATER EL: 79.8 FT

LD3-057



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- →•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- ---- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

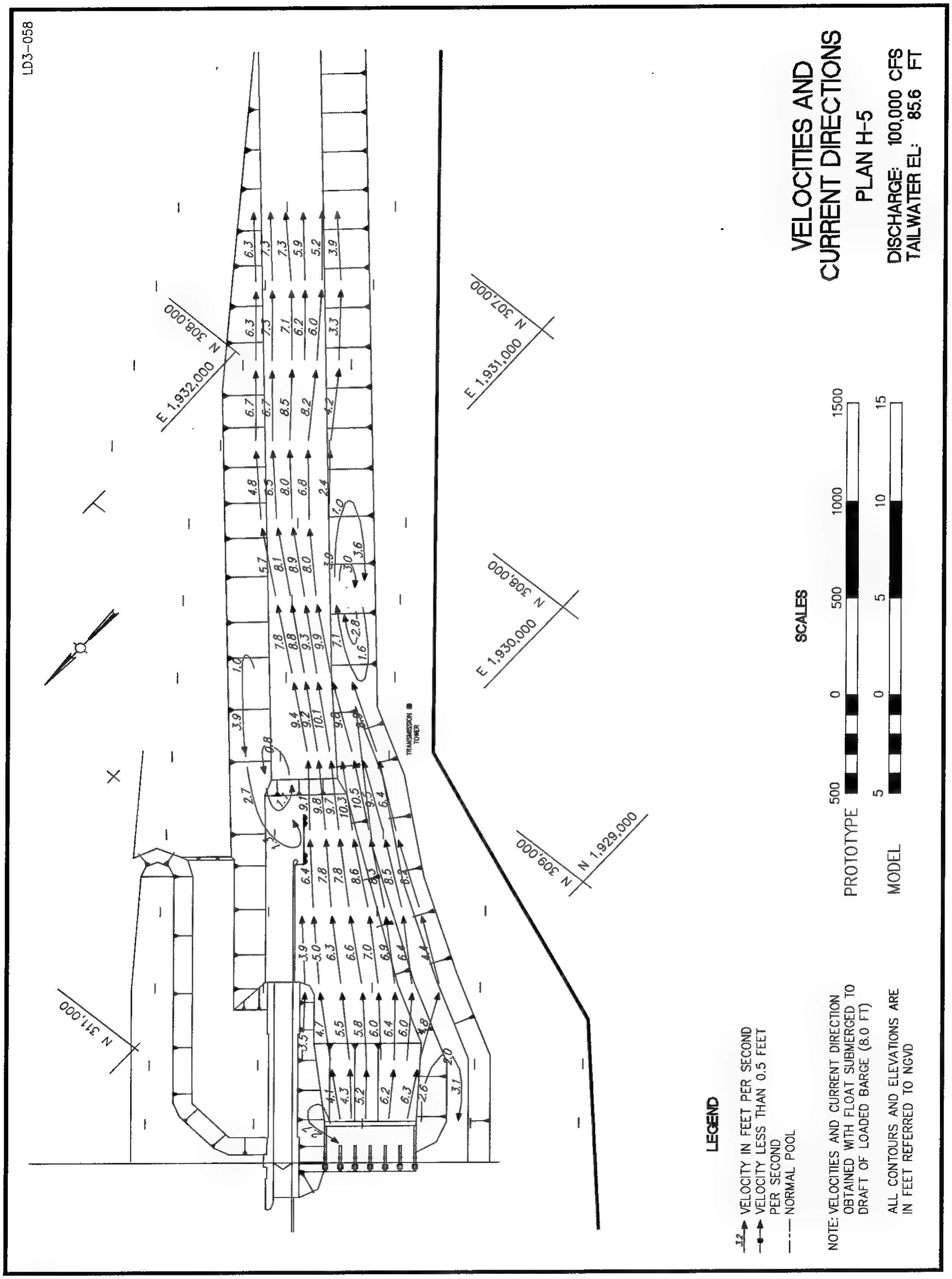
PROTOTYPE 500 0 500 1000 1500

MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

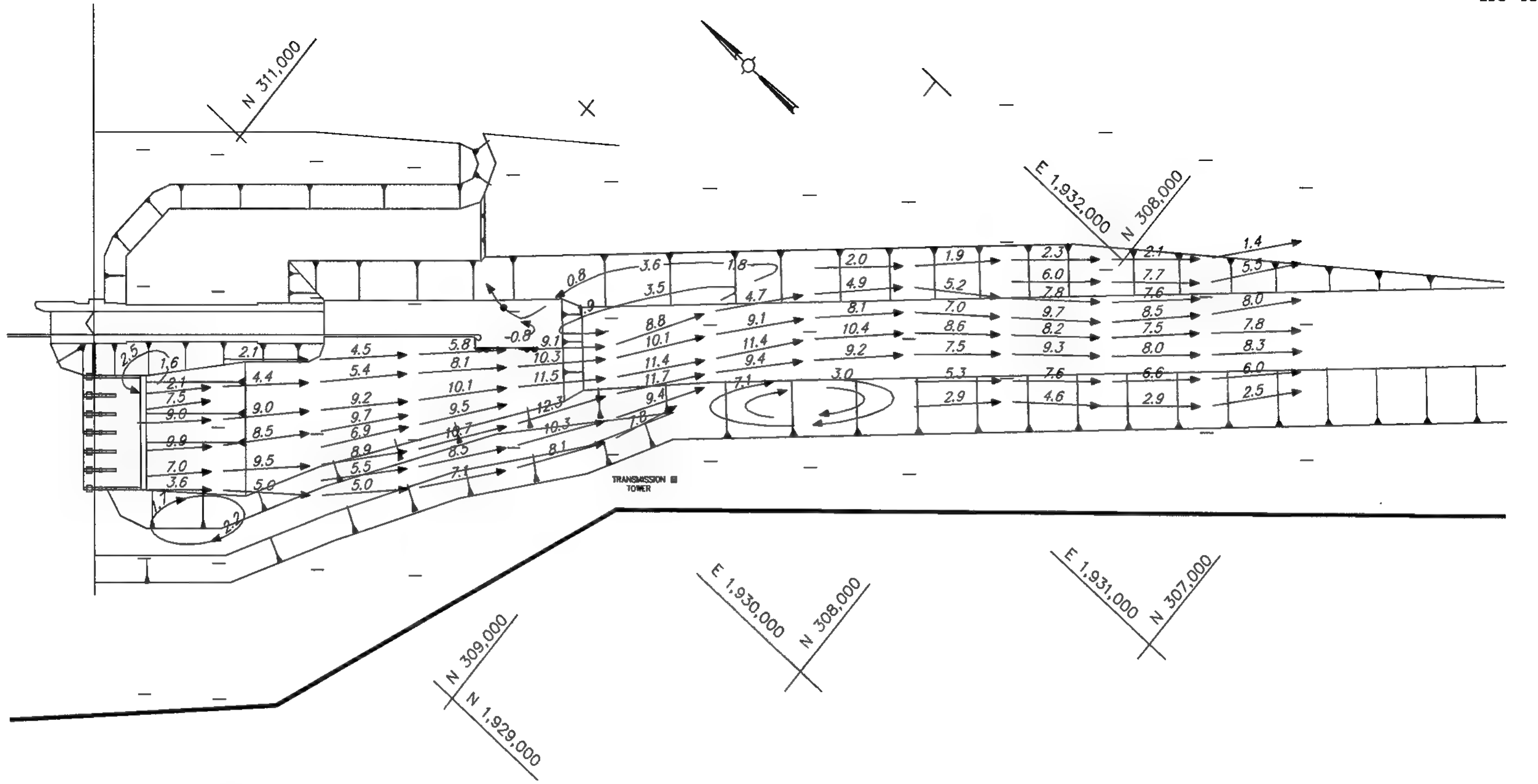
PLAN H-5

DISCHARGE: 80,000 CFS
TAILWATER EL: 83.0 FT



LD3-058
VELOCITIES AND
CURRENT DIRECTIONS
PLAN H-5
DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT
SCALES
PROTOTYPE 500 0 500 1000 1500
MODEL 5 0 5 10 15
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
N 311,000
N 309,000
N 308,000
N 307,000
E 1,929,000
E 1,930,000
E 1,931,000
E 1,932,000
TRANSMISSION TOWER

LD3-059



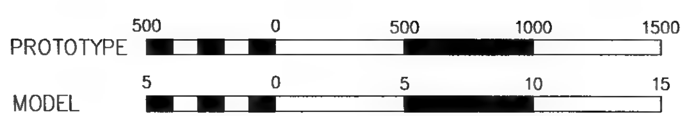
LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- →•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- — - — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

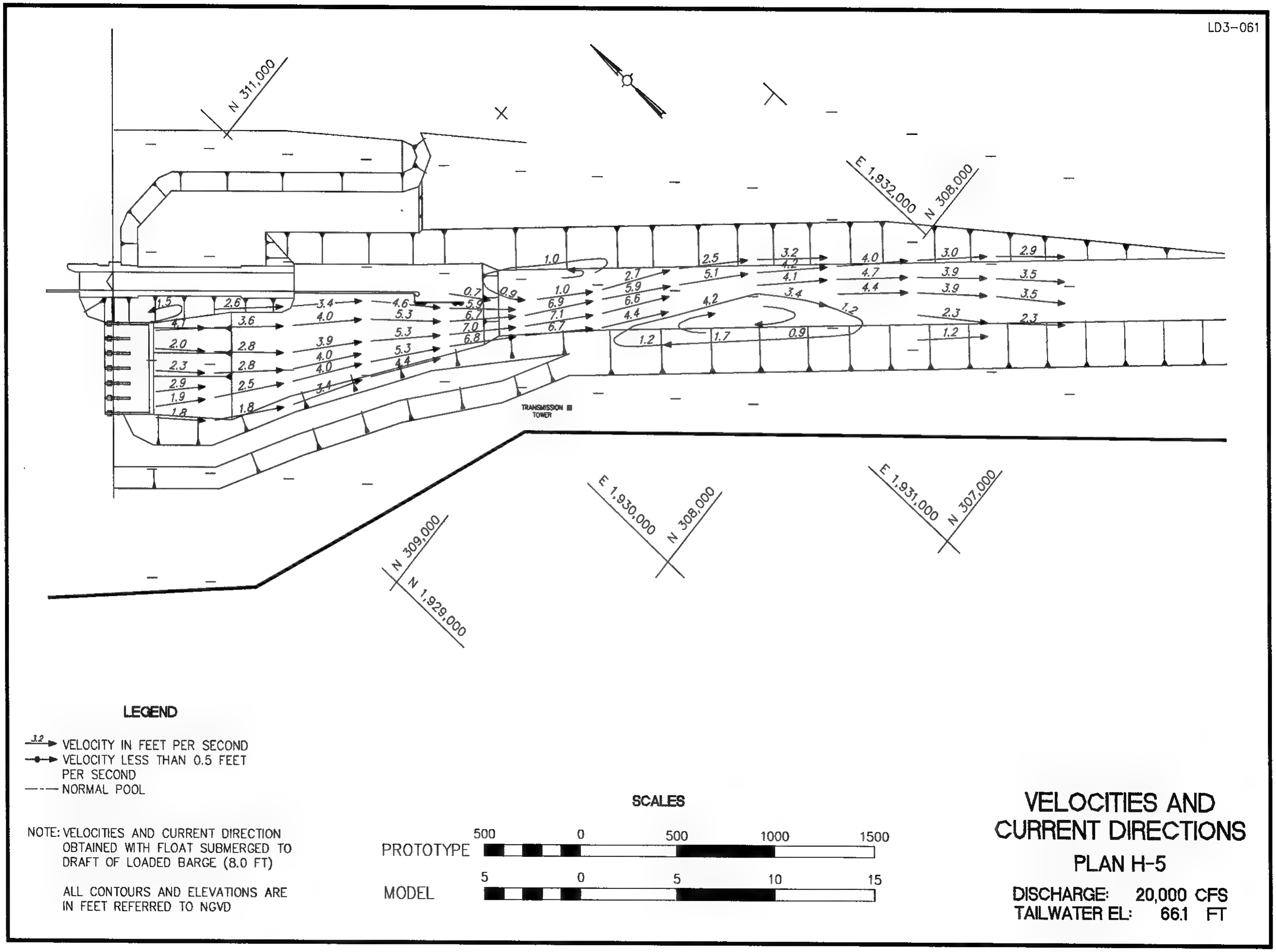
SCALES



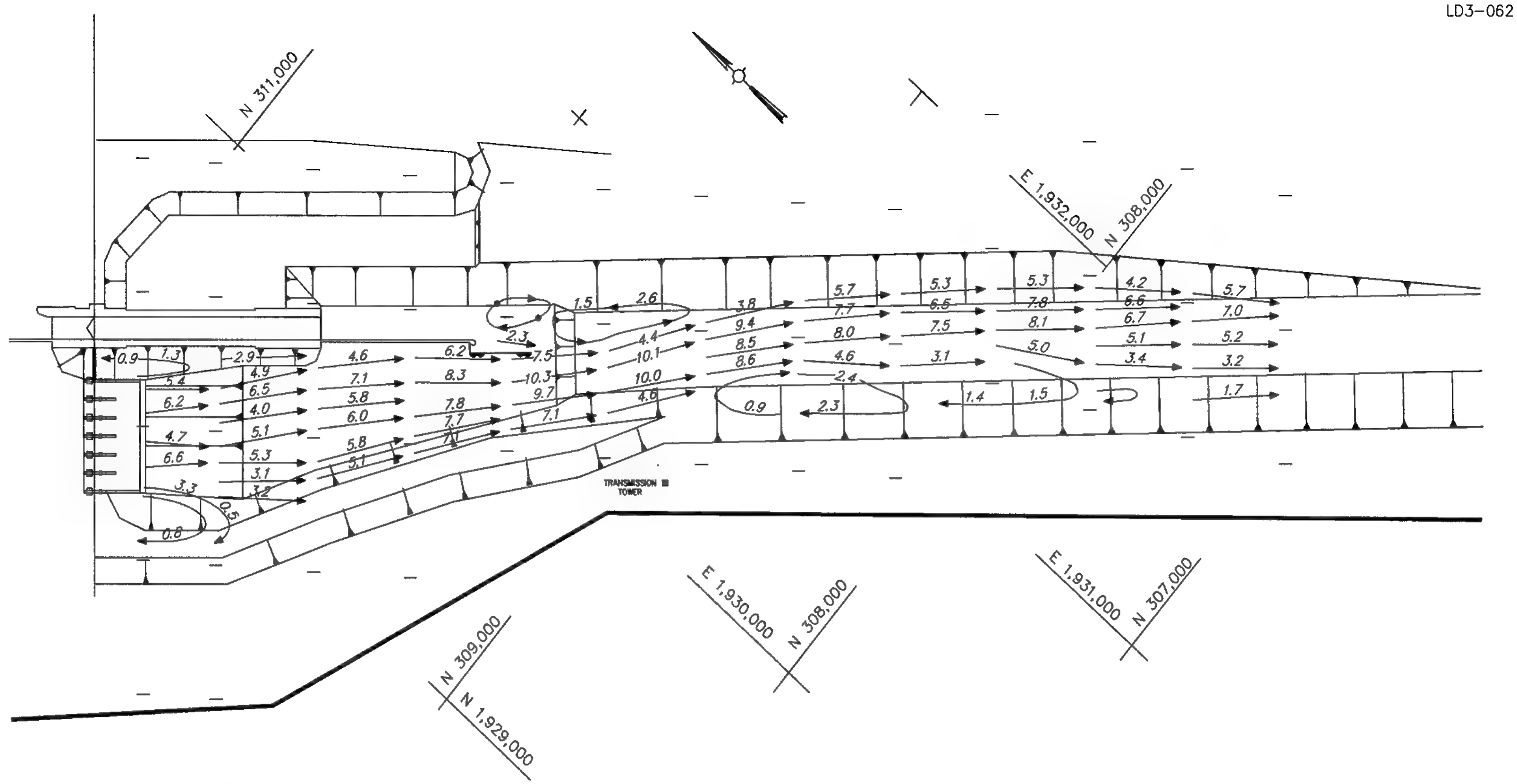
VELOCITIES AND CURRENT DIRECTIONS

PLAN H-5

DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT


LD3-061
N 311,000
E 1,932,000
N 308,000
N 309,000
N 1,929,000
E 1,930,000
N 308,000
E 1,931,000
N 307,000
TRANSMISSION TOWER
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SCALES
PROTOTYPE
500 0 500 1000 1500
MODEL
5 0 5 10 15
VELOCITIES AND CURRENT DIRECTIONS
PLAN H-5
DISCHARGE: 20,000 CFS
TAILWATER EL: 66.1 FT

LD3-062



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- ●→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- — - — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE	500	0	500	1000	1500
MODEL	5	0	5	10	15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-5

DISCHARGE: 60,000 CFS
TAILWATER EL: 76.0 FT

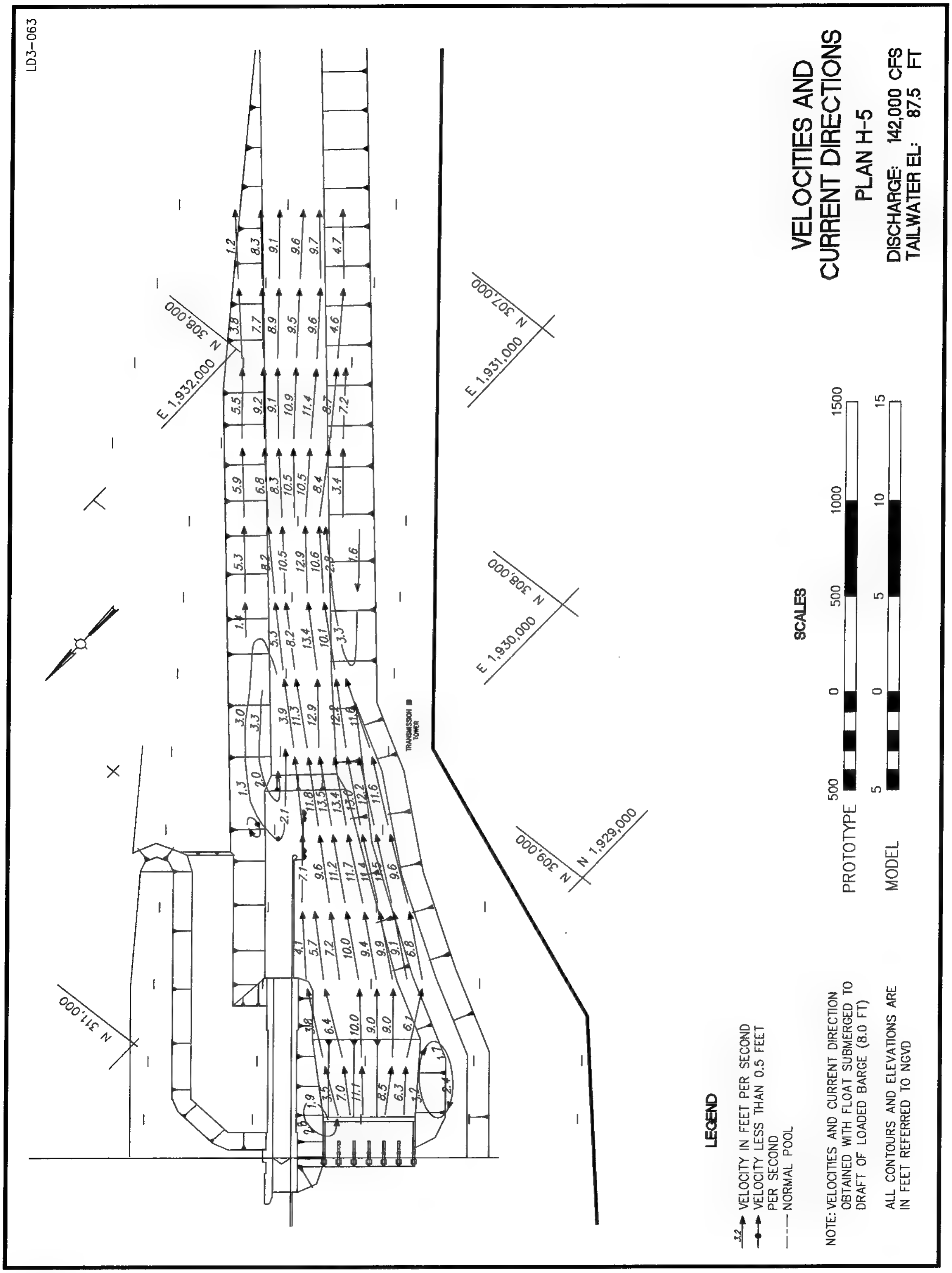
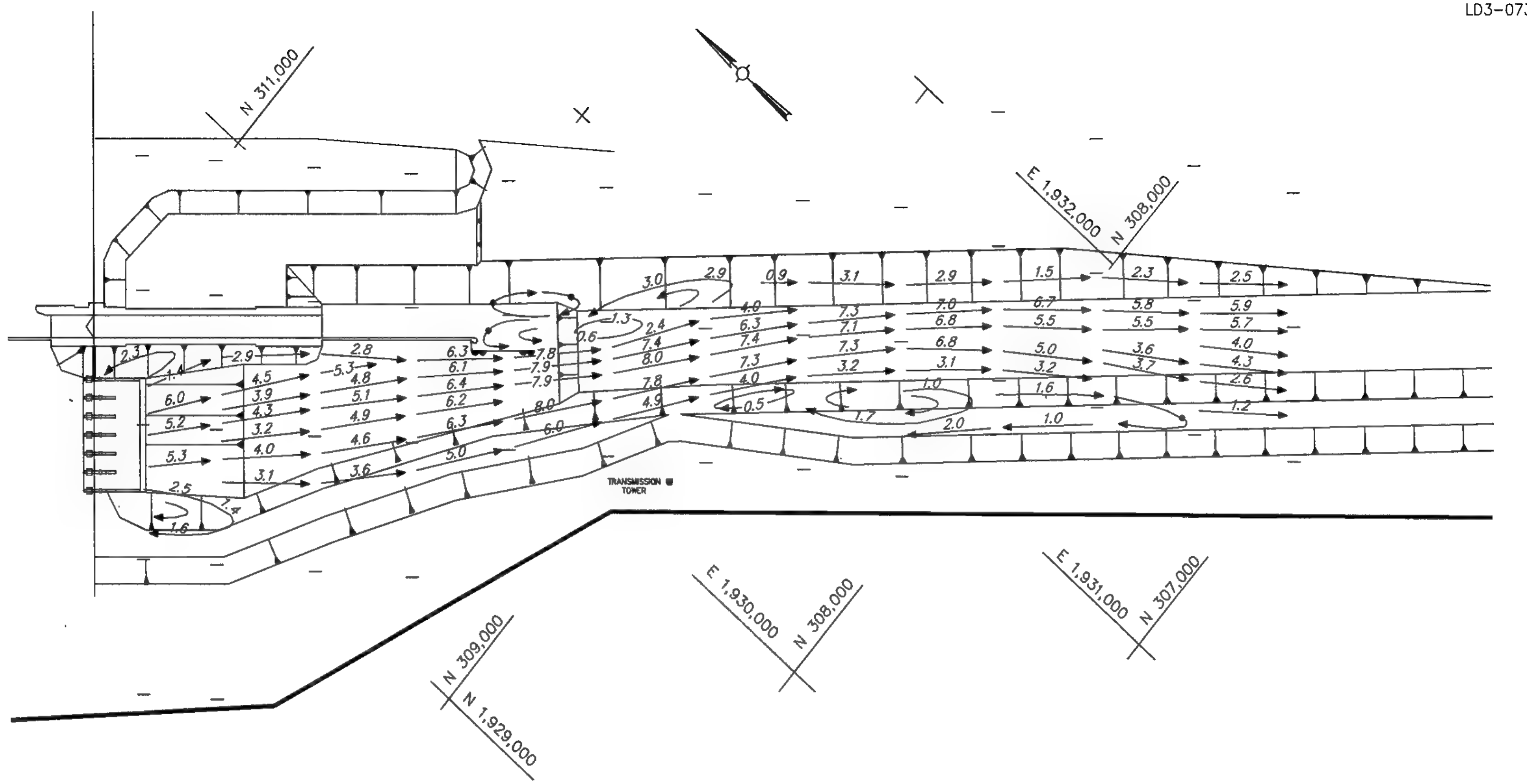

LD3-063
VELOCITIES AND CURRENT DIRECTIONS
PLAN H-5
DISCHARGE: 142,000 CFS
TAILWATER EL: 87.5 FT
SCALES
PROTOTYPE 500 0 500 1000 1500
MODEL 5 0 5 10 15
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
TRANSMISSION TOWER
E 1,932,000
N 308,000
E 1,931,000
N 307,000
E 1,930,000
N 308,000
N 309,000
N 1,929,000
N 311,000

Plate 90

LD3-073



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- •→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- —·— NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

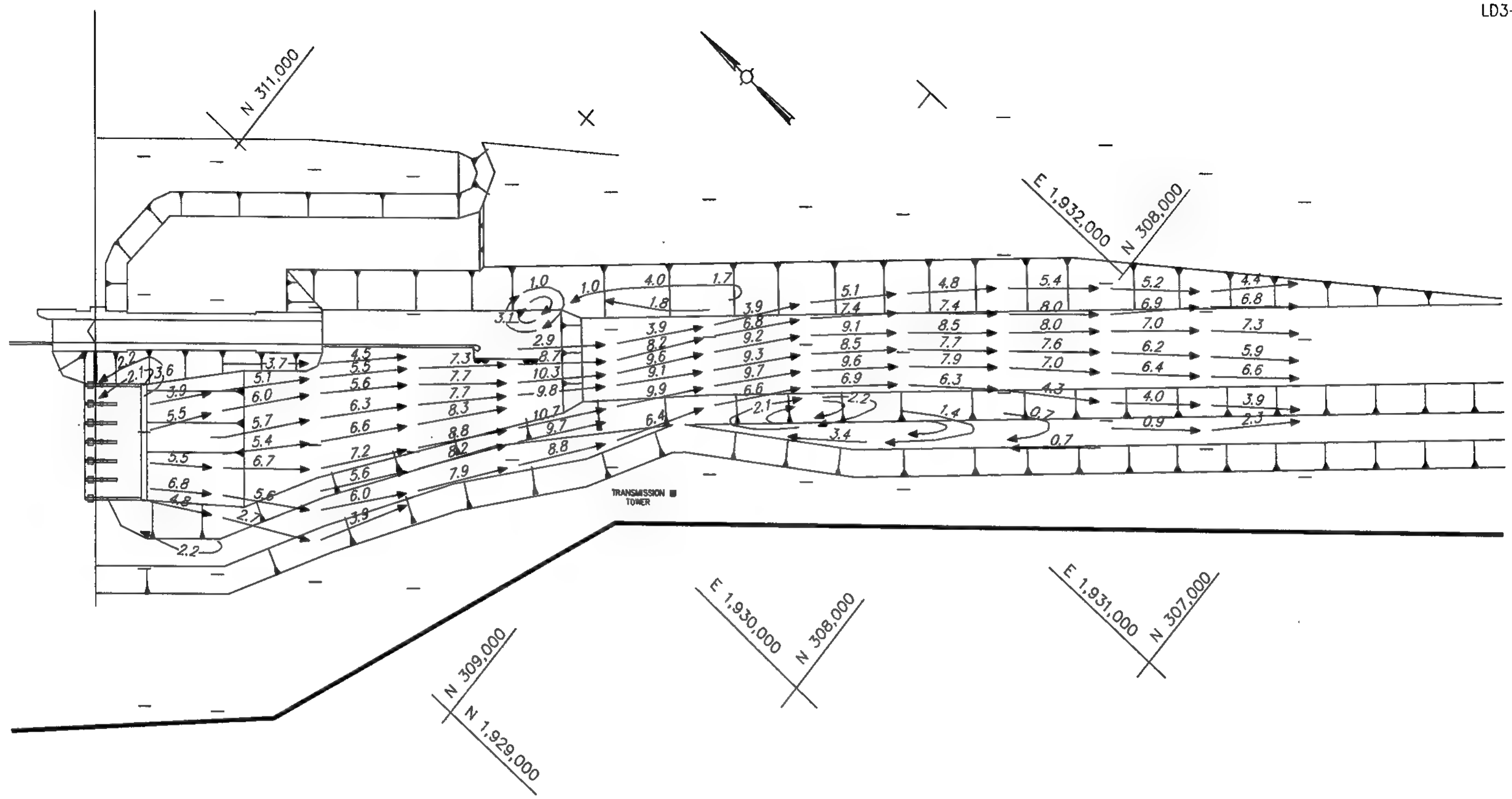
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-6

DISCHARGE: 60,000 CFS
TAILWATER EL: 79.8 FT

LD3-071



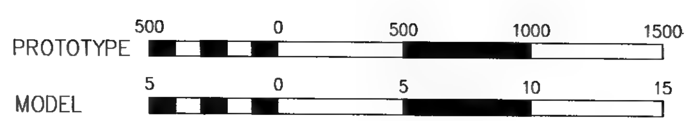
LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- → VELOCITY LESS THAN 0.5 FEET PER SECOND
- — - — NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

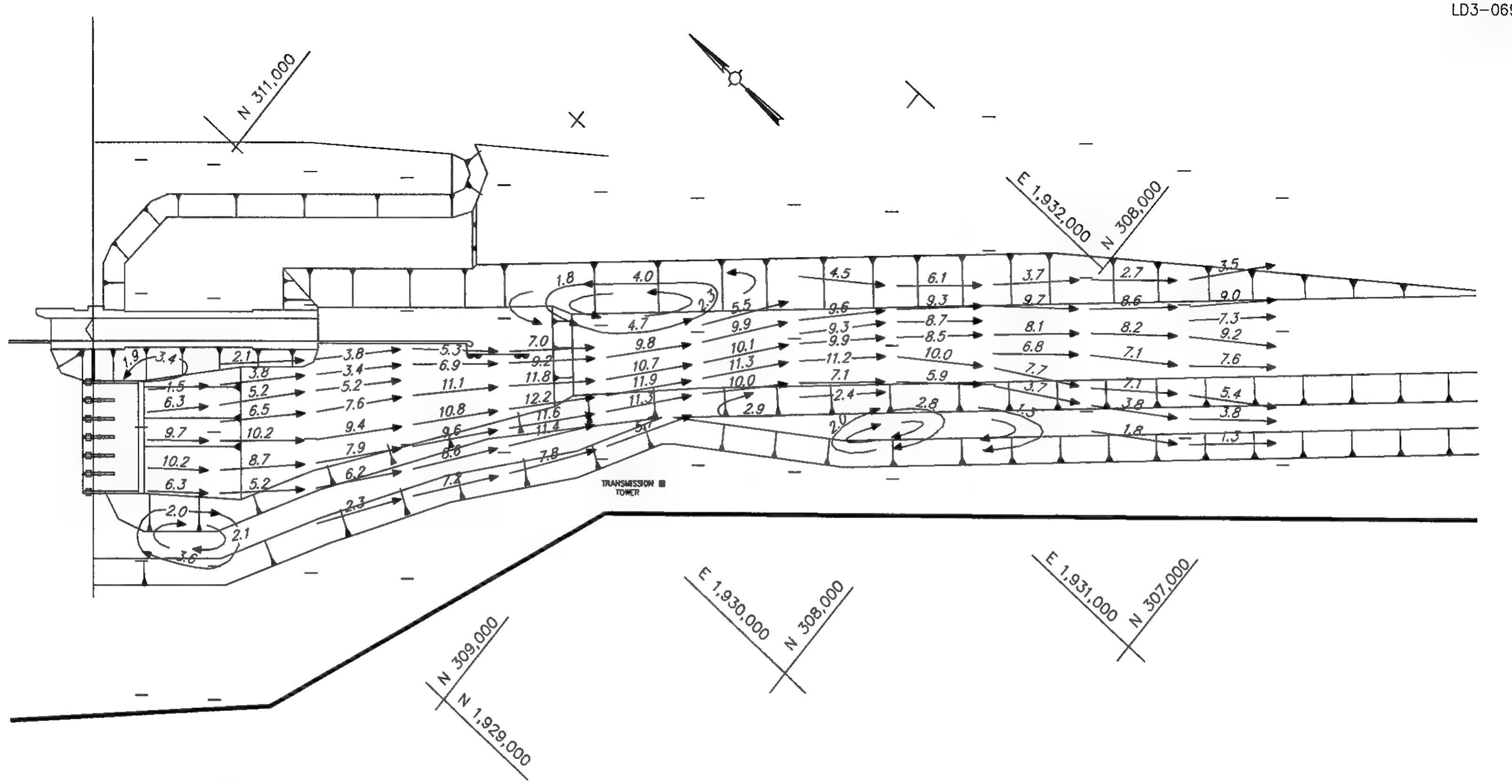


VELOCITIES AND CURRENT DIRECTIONS

PLAN H-6

DISCHARGE: 100,000 CFS
TAILWATER EL: 85.6 FT

LD3-069



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- →•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- —·— NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500

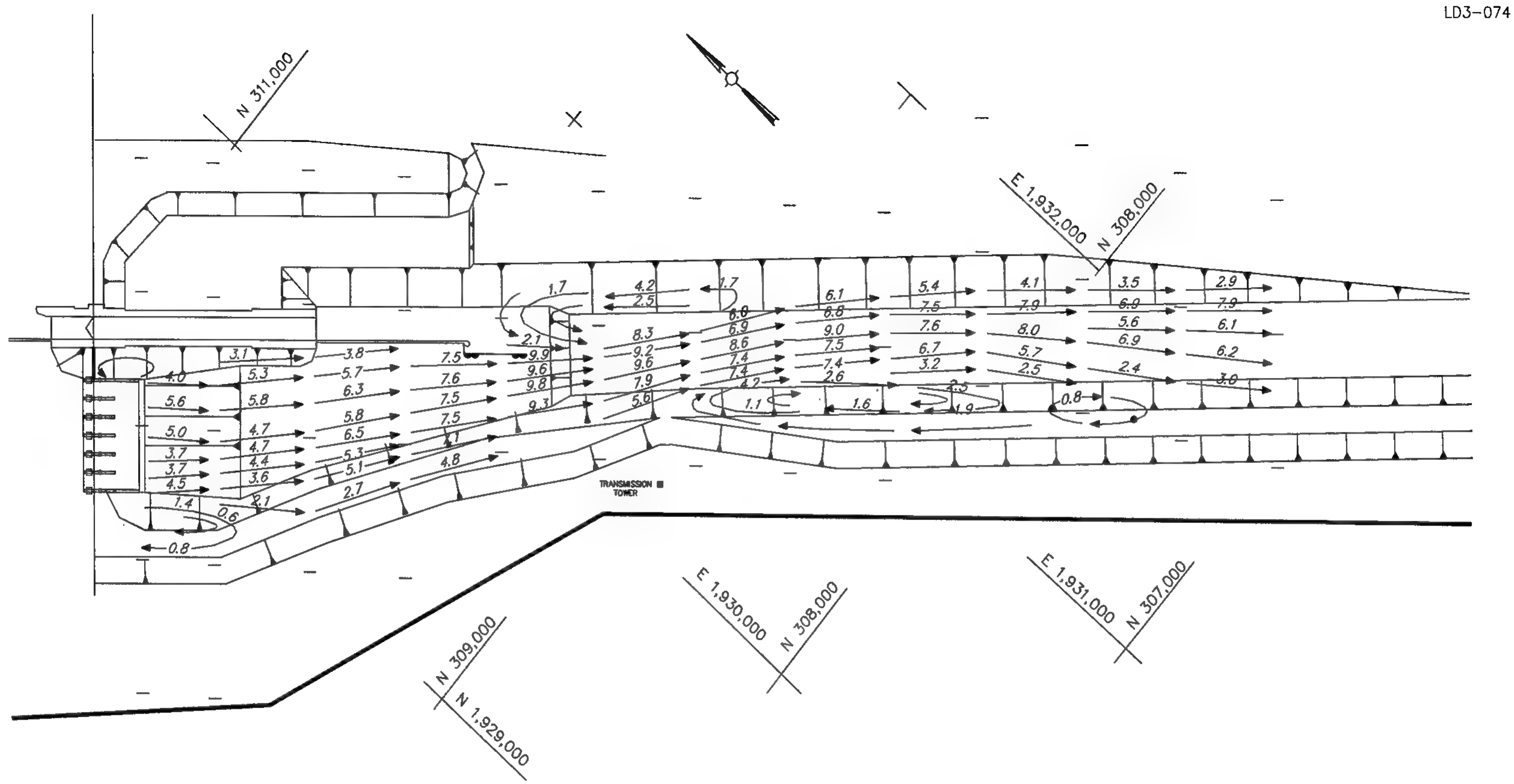
MODEL 5 0 5 10 15

VELOCITIES AND CURRENT DIRECTIONS

PLAN H-6

DISCHARGE: 142,000 CFS
TAILWATER EL: 91.5 FT

LD3-074



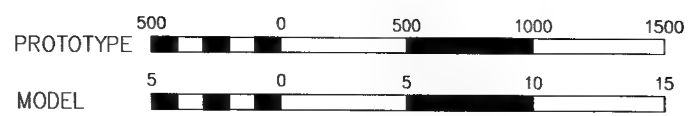
LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- —●→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- —·—· NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

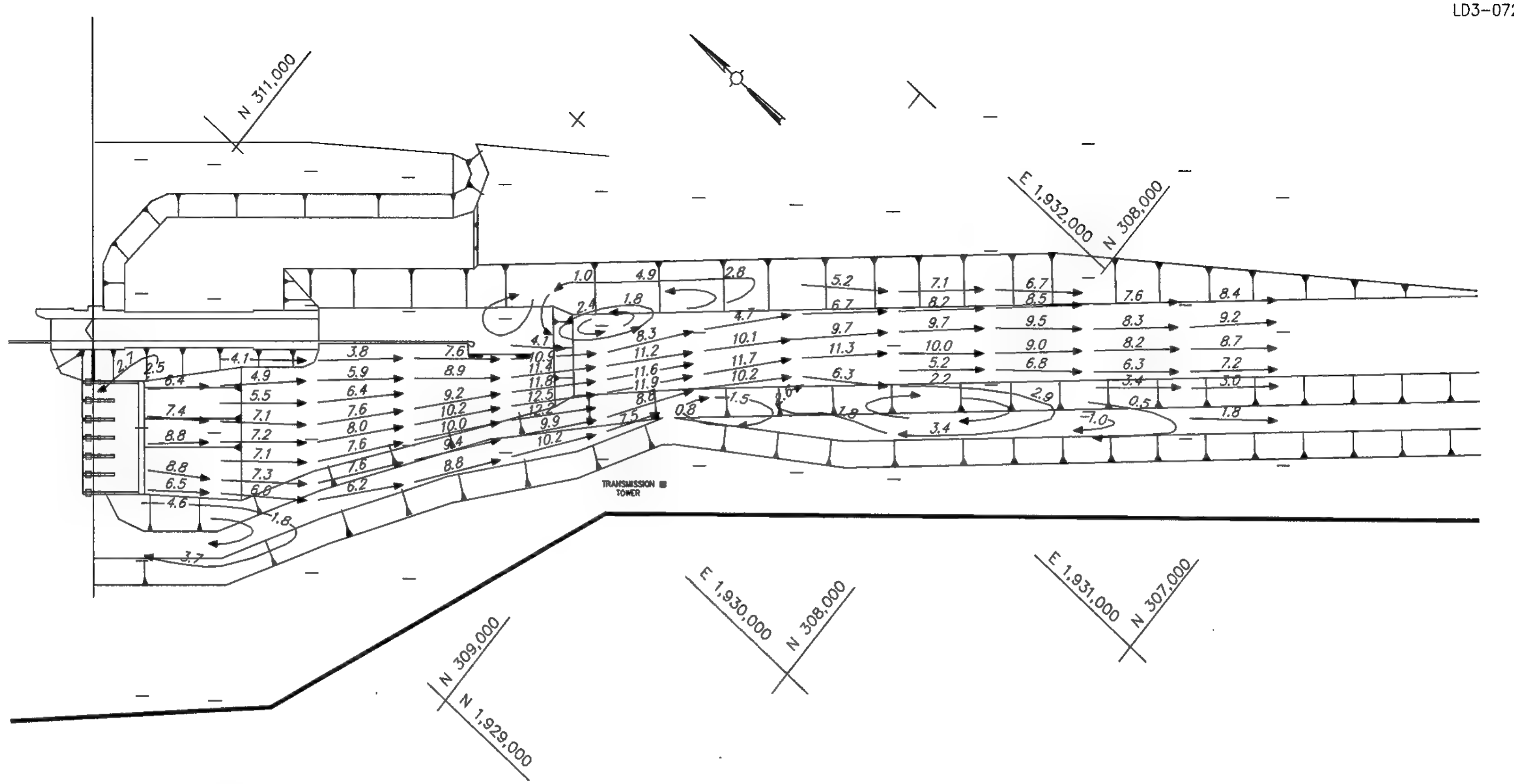


VELOCITIES AND CURRENT DIRECTIONS

PLAN H-6

DISCHARGE: 60,000 CFS
TAILWATER EL: 76.0 FT

LD3-072



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- NORMAL POOL

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

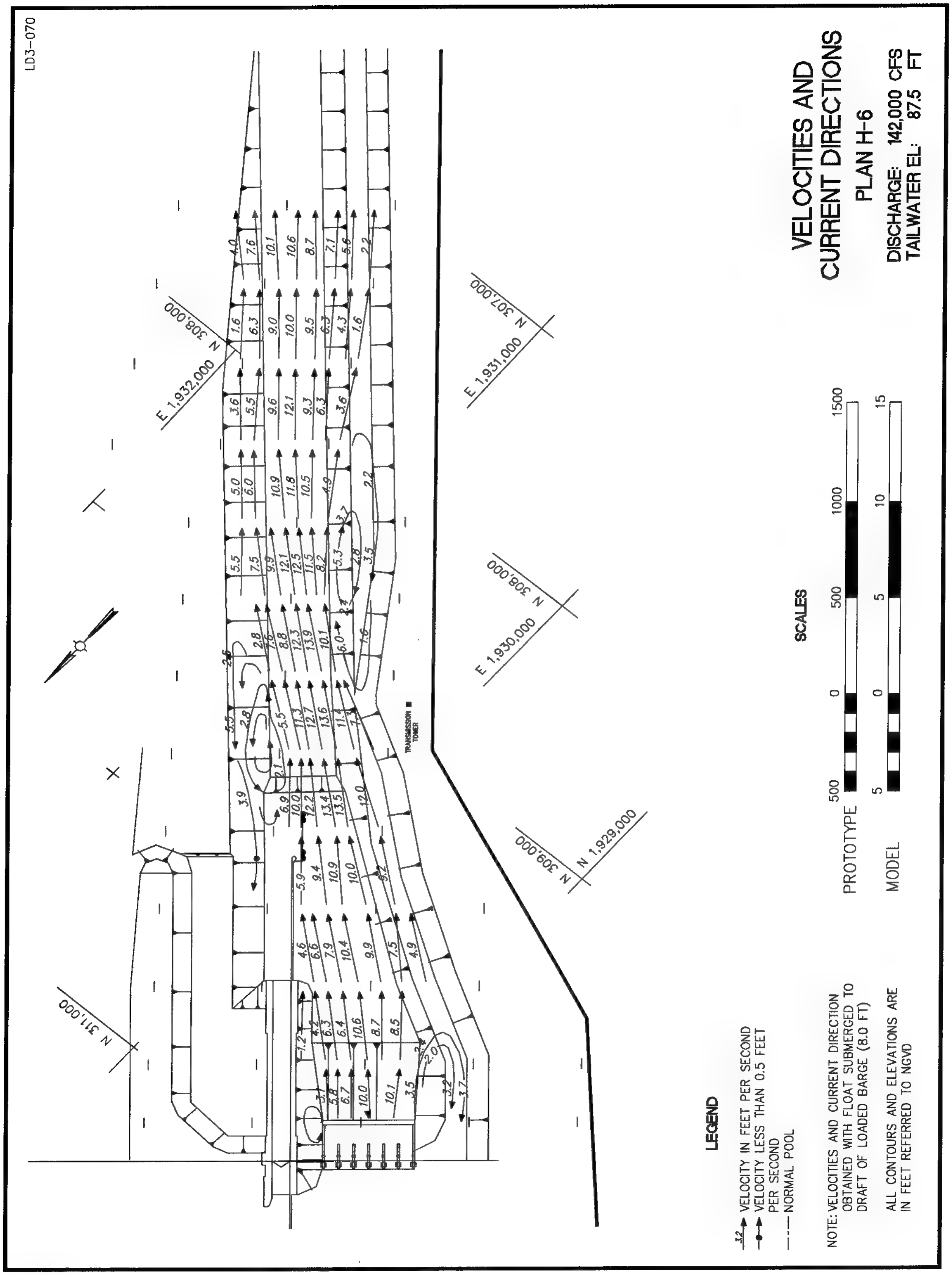
PROTOTYPE 500 0 500 1000 1500

MODEL 5 0 5 10 15

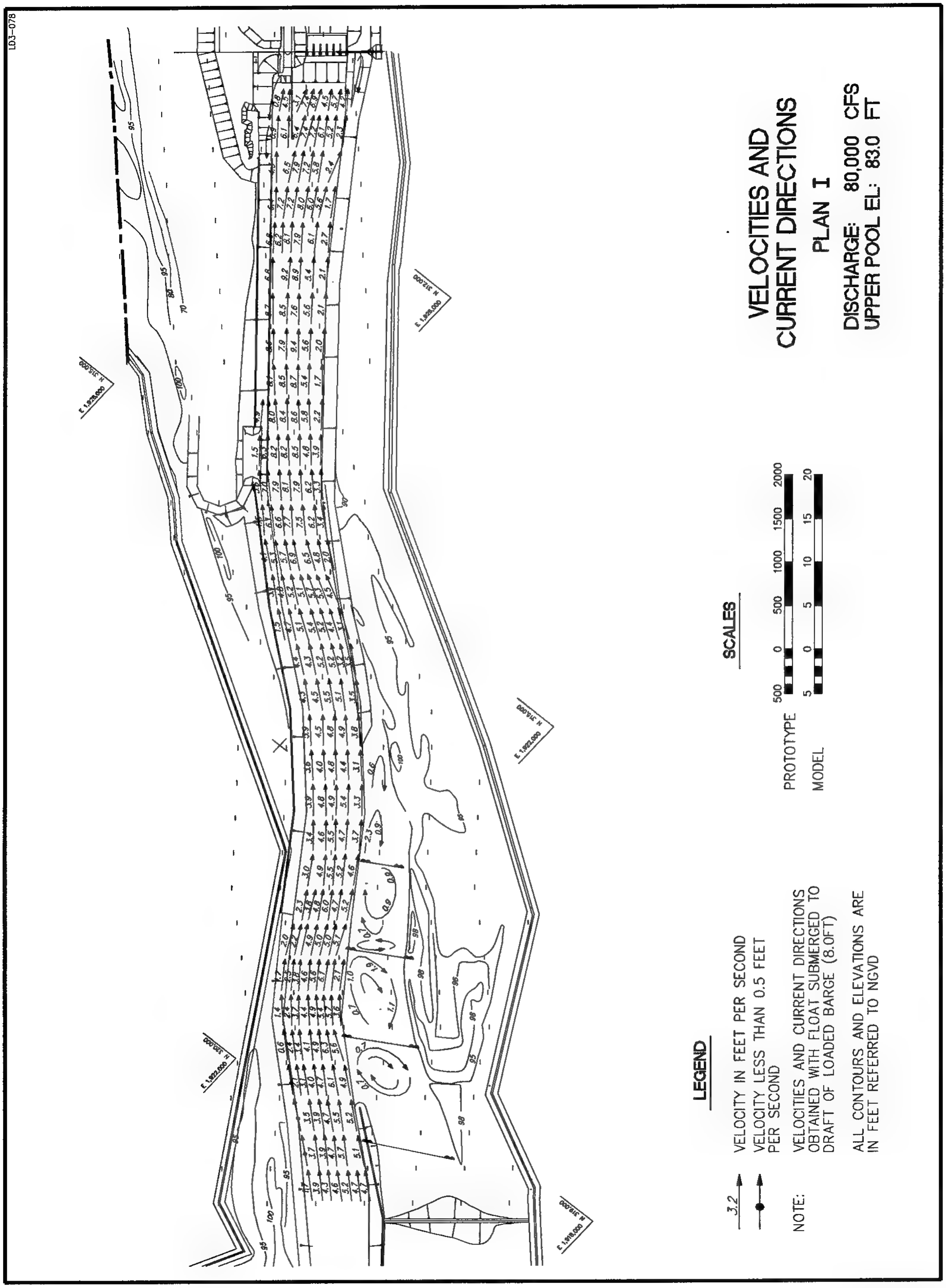
VELOCITIES AND CURRENT DIRECTIONS

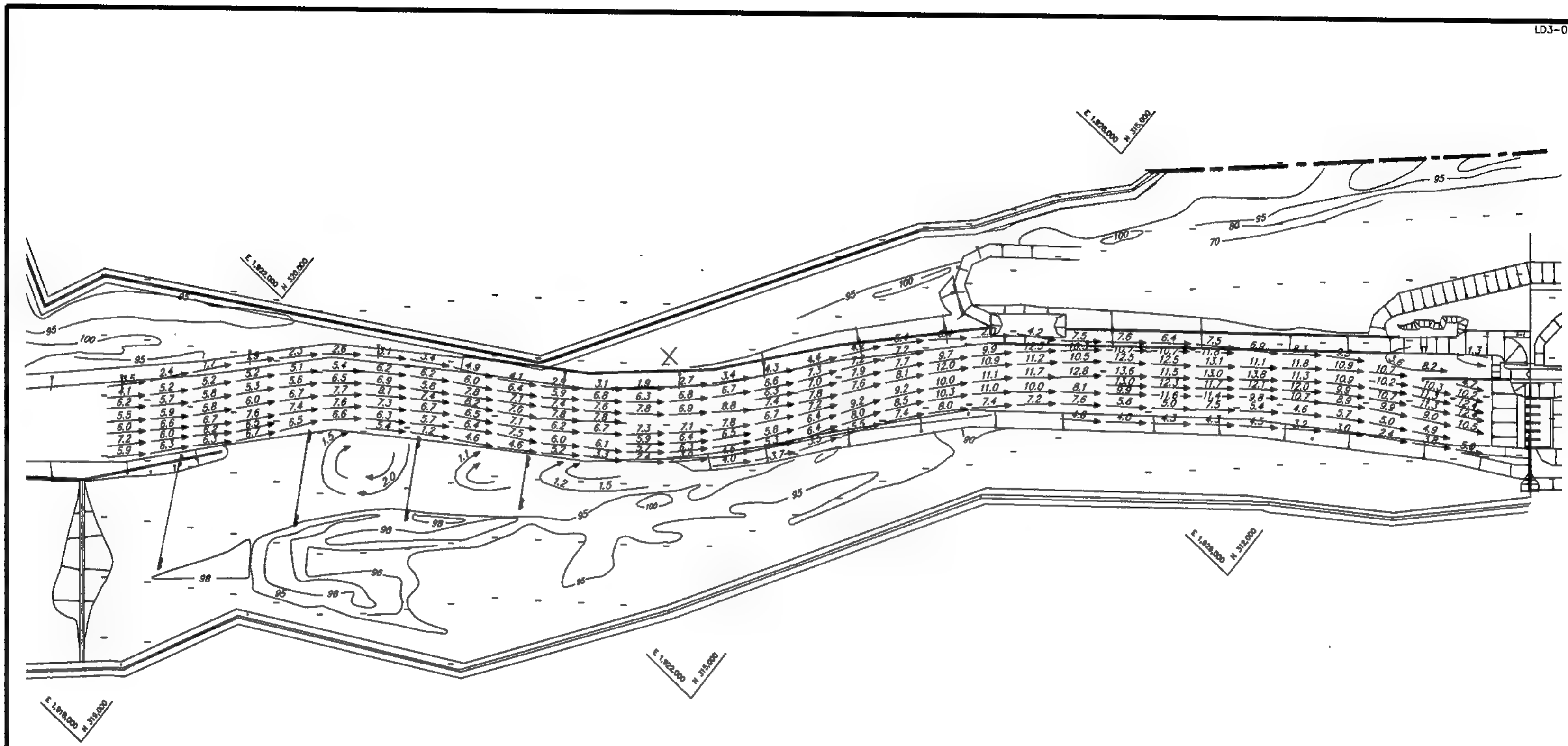
PLAN H-6

DISCHARGE: 100,000 CFS
TAILWATER EL: 81.5 FT



LD3-070
VELOCITIES AND CURRENT DIRECTIONS
PLAN H-6
DISCHARGE: 142,000 CFS
TAILWATER EL: 87.5 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NORMAL POOL
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SCALES
PROTOTYPE
MODEL
TRANSMISSION TOWER
N 311,000
N 309,000
N 308,000
N 307,000
E 1,932,000
E 1,931,000
E 1,930,000
E 1,929,000


LD3-078
VELOCITIES AND CURRENT DIRECTIONS
PLAN I
DISCHARGE: 80,000 CFS
UPPER POOL EL: 83.0 FT
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SCALES
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

—●→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500 2000

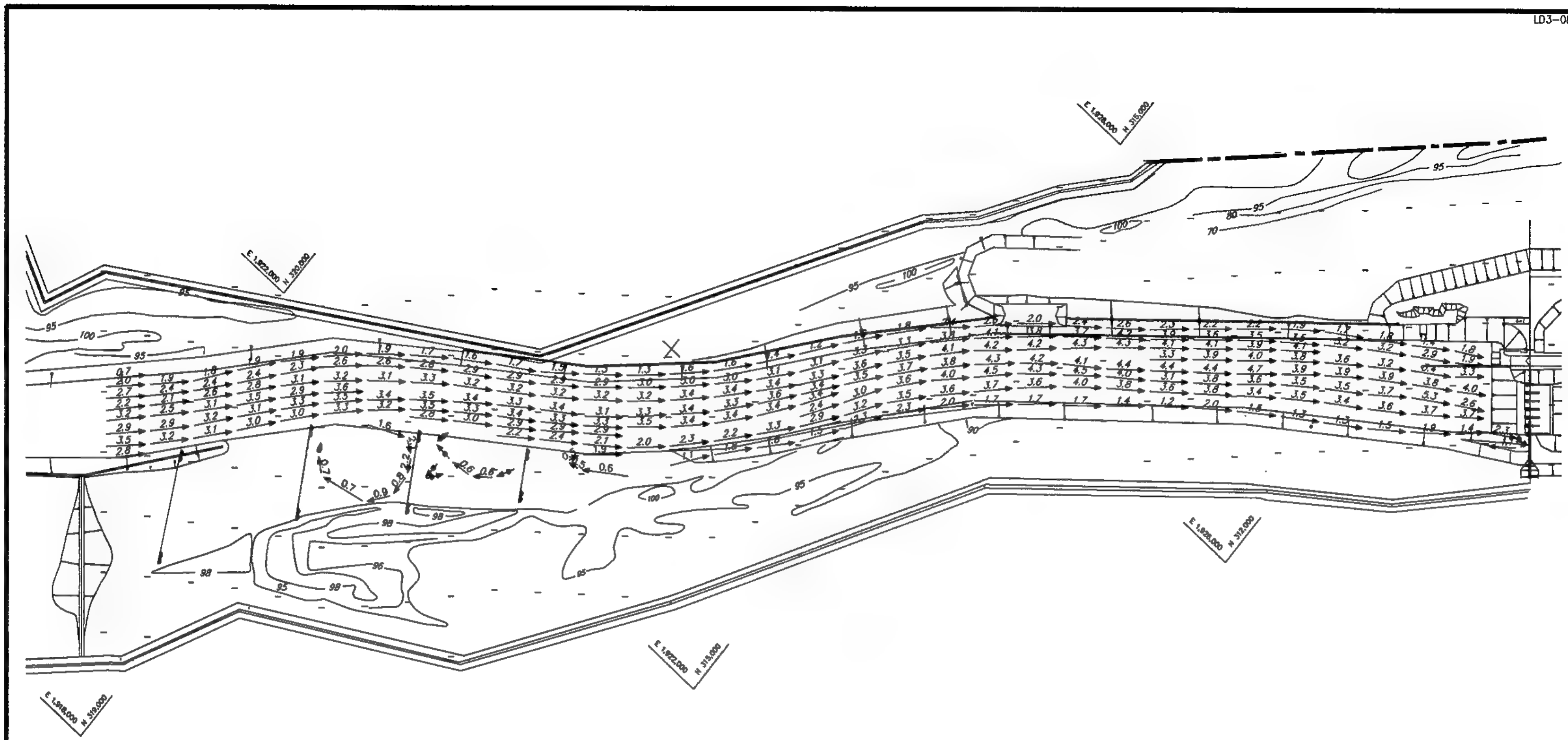
MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I

DISCHARGE: 142,000 CFS

UPPER POOL EL: 92.4 FT



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

●→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE	500	0	500	1000	1500	2000
MODEL	5	0	5	10	15	20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I-1

DISCHARGE: 60,000 CFS
UPPER POOL EL: 94.0 FT

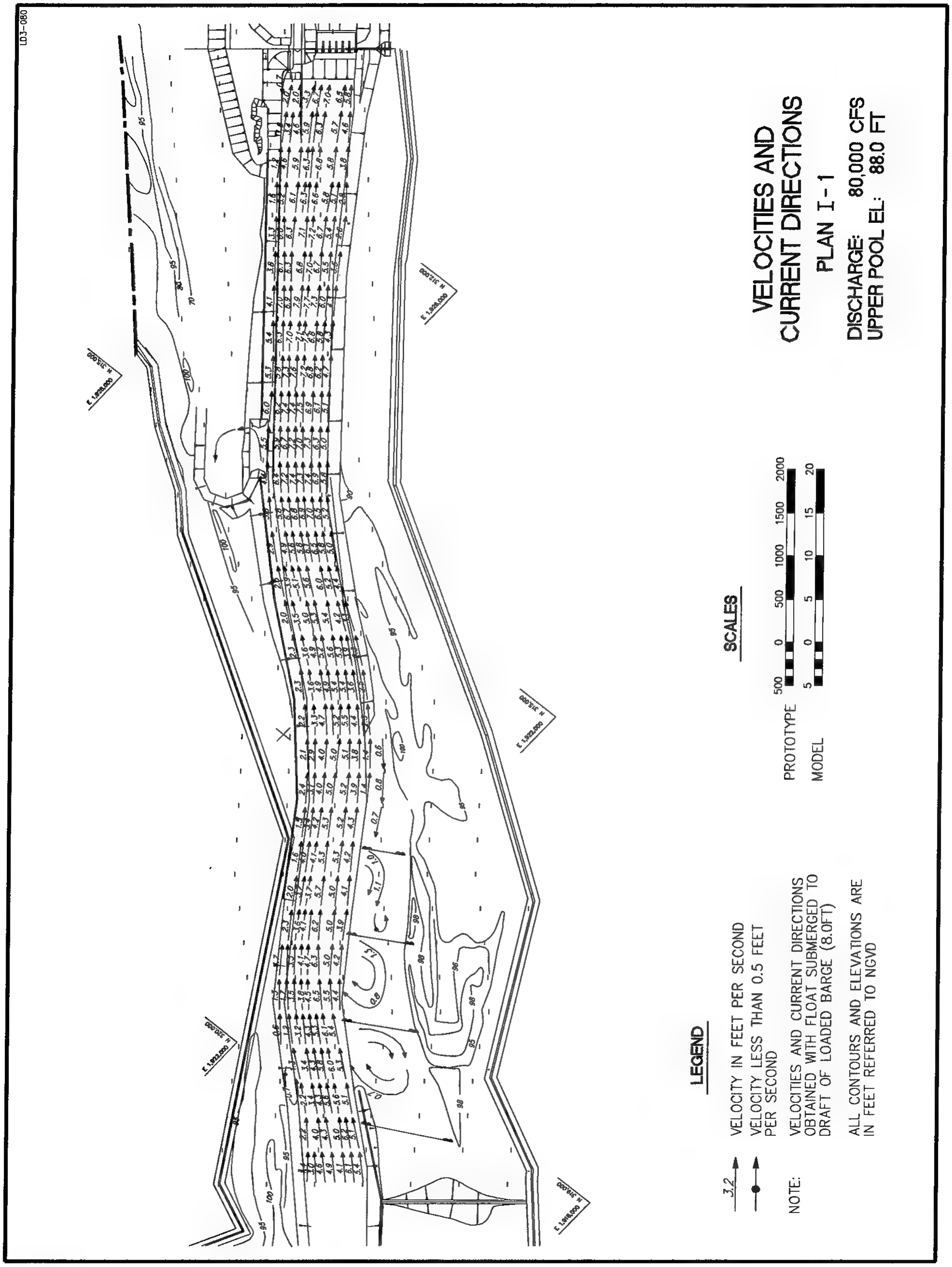
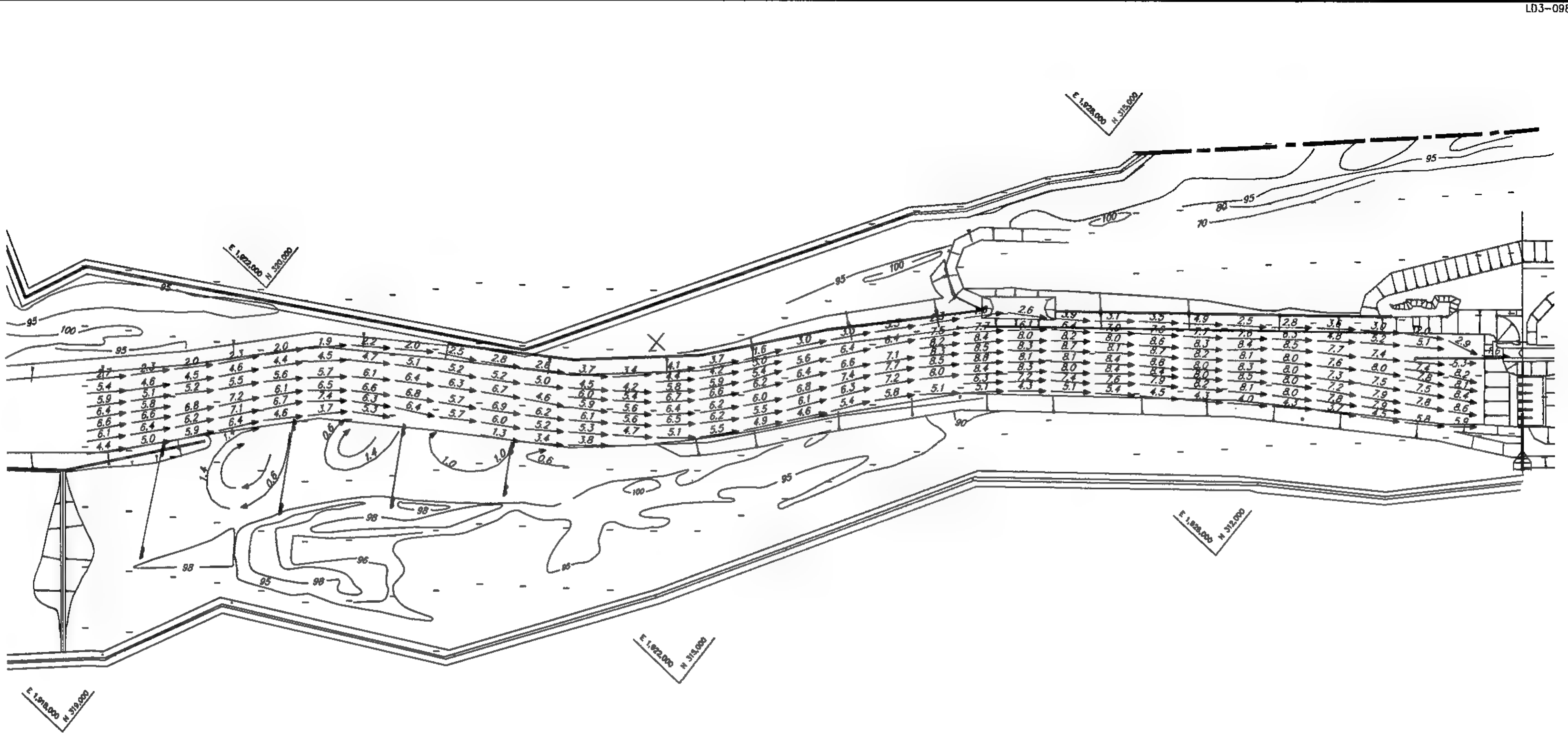

LD3-080
VELOCITIES AND CURRENT DIRECTIONS
PLAN I-1
DISCHARGE: 80,000 CFS
UPPER POOL EL: 88.0 FT
SCALES
PROTOTYPE
MODEL
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

Plate 100



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

—●→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

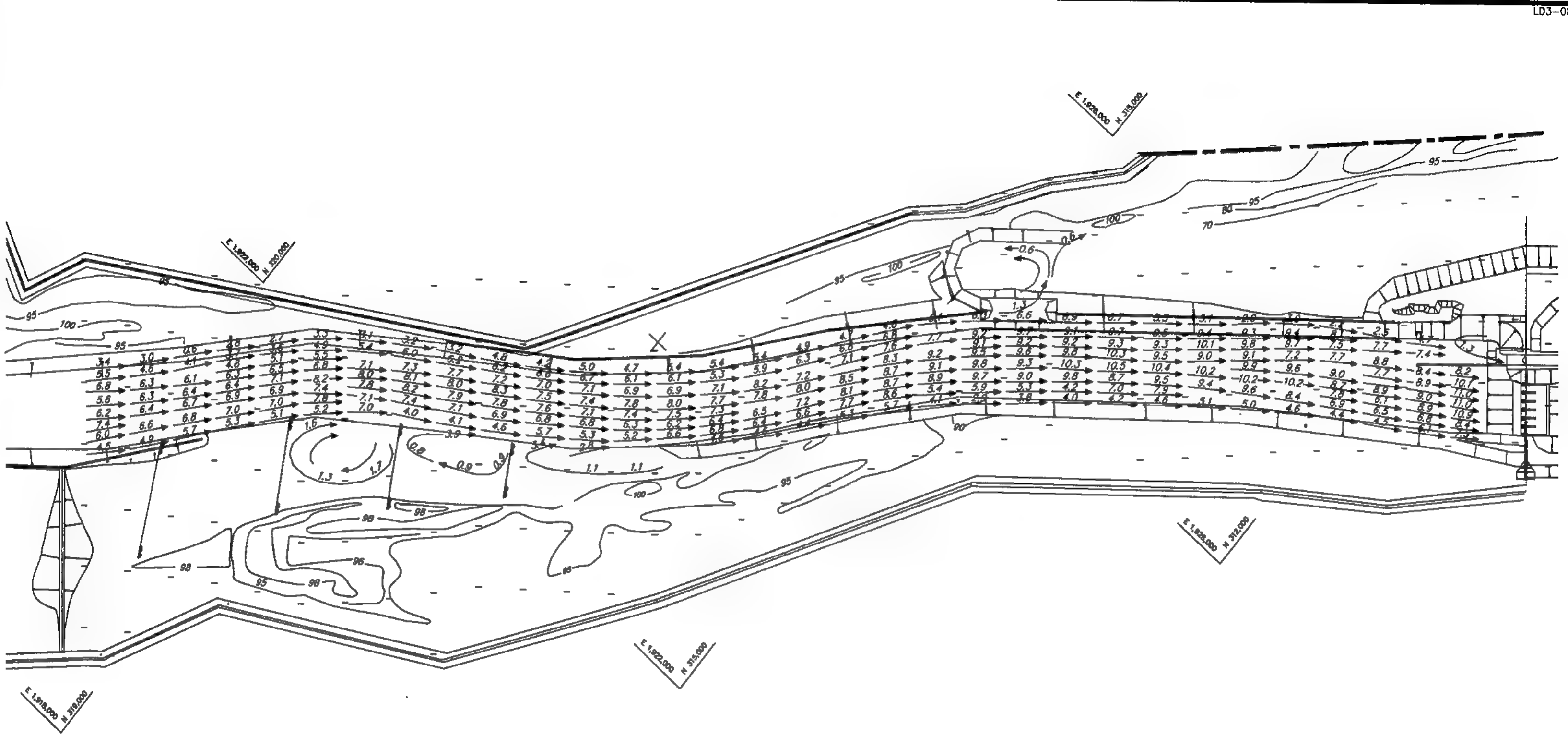
PROTOTYPE 500 0 500 1000 1500 2000

MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I-1

DISCHARGE: 100,000 CFS
UPPER POOL EL: 89.0 FT



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

—●→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500 2000

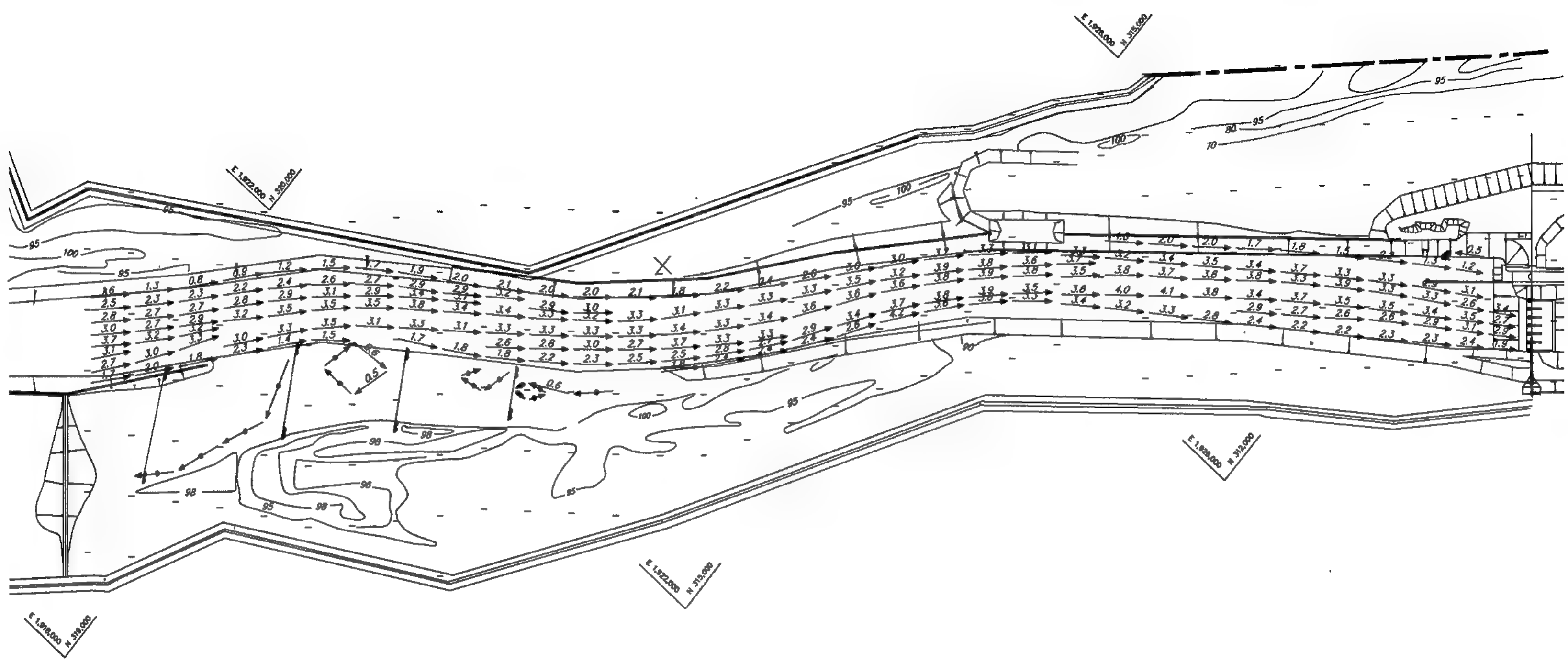
MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I-1

DISCHARGE: 142,000 CFS
UPPER POOL EL: 92.5 FT

LD3-086



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- ●→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

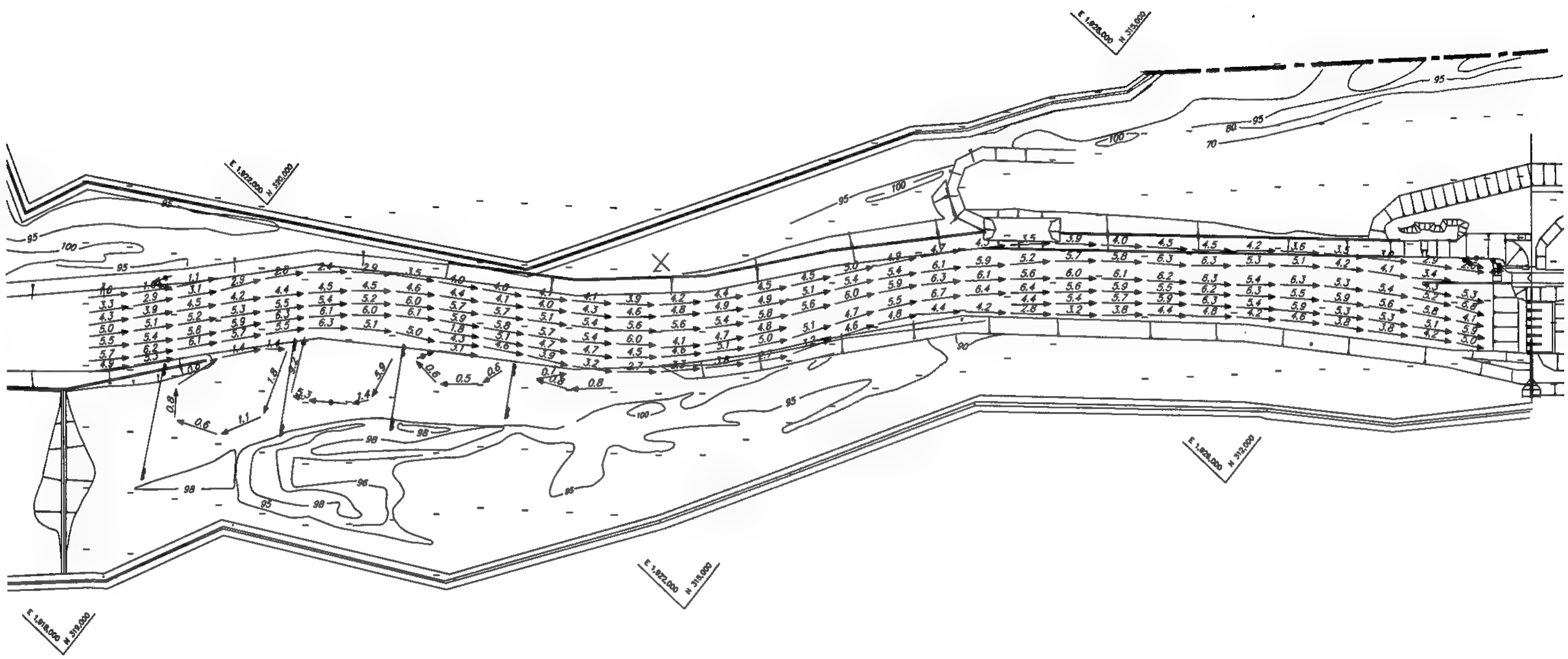
PROTOTYPE 500 0 500 1000 1500 2000

MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I - 2

DISCHARGE: 60,000 CFS
UPPER POOL EL: 94.0 FT



LEGEND

3.2 — VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

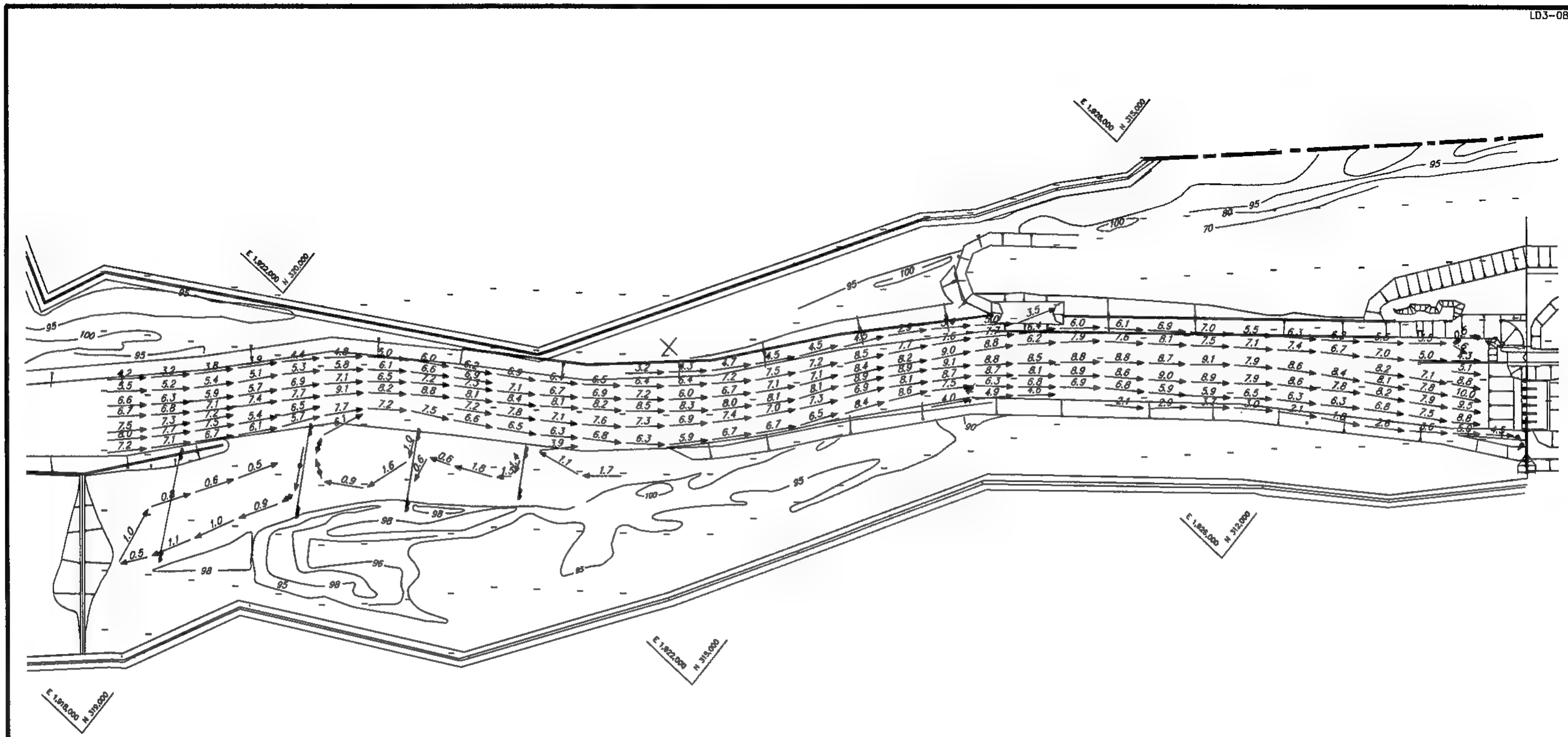
SCALES

PROTOTYPE	500	0	500	1000	1500	2000
MODEL	5	0	5	10	15	20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I - 2

DISCHARGE: 80,000 CFS
UPPER POOL EL: 88.0 FT



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

—●→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

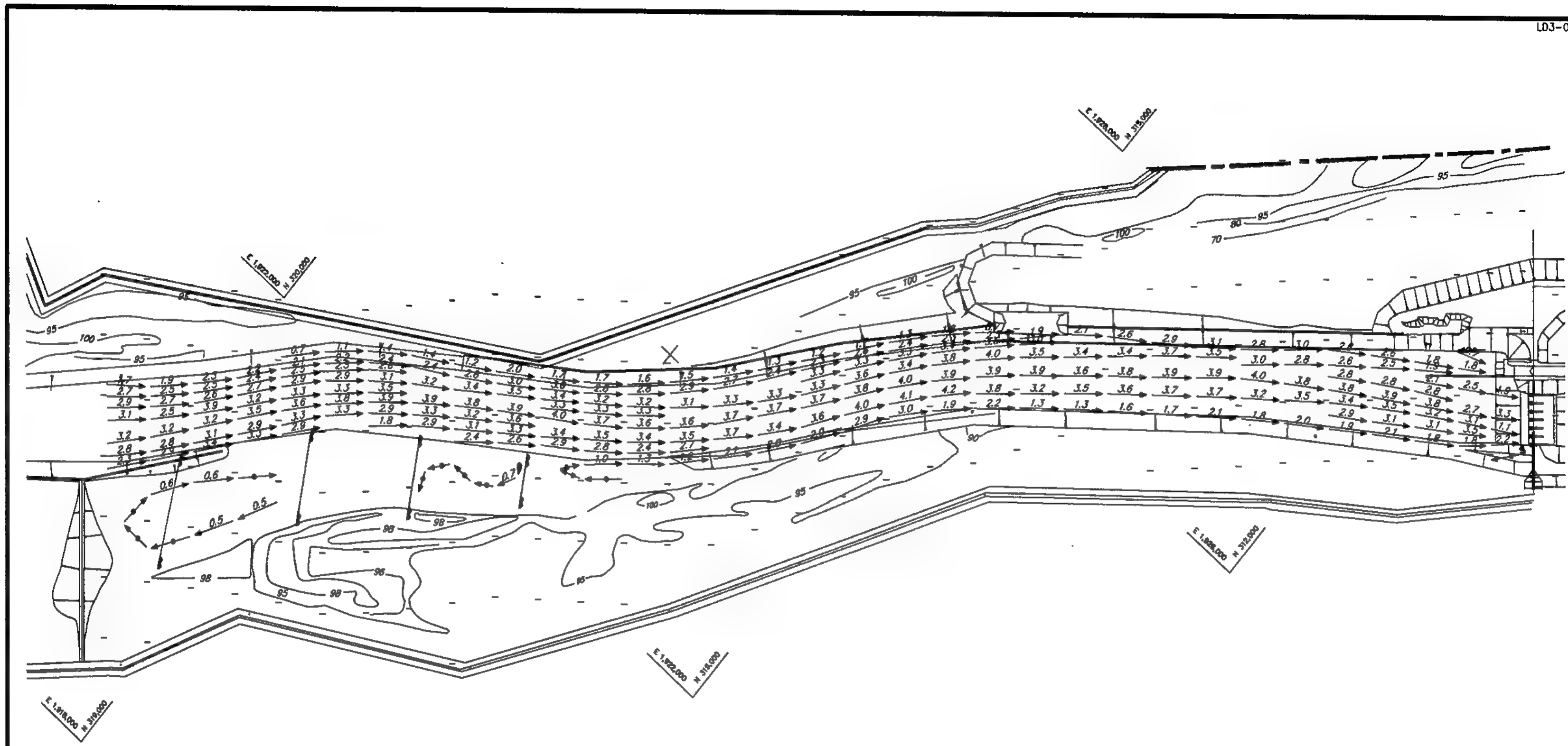
PROTOTYPE 500 0 500 1000 1500 2000

MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I - 2

DISCHARGE: 142,000 CFS
UPPER POOL EL: 92.5 FT



LEGEND

- 3.2 → VELOCITY IN FEET PER SECOND
- →●→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500 2000

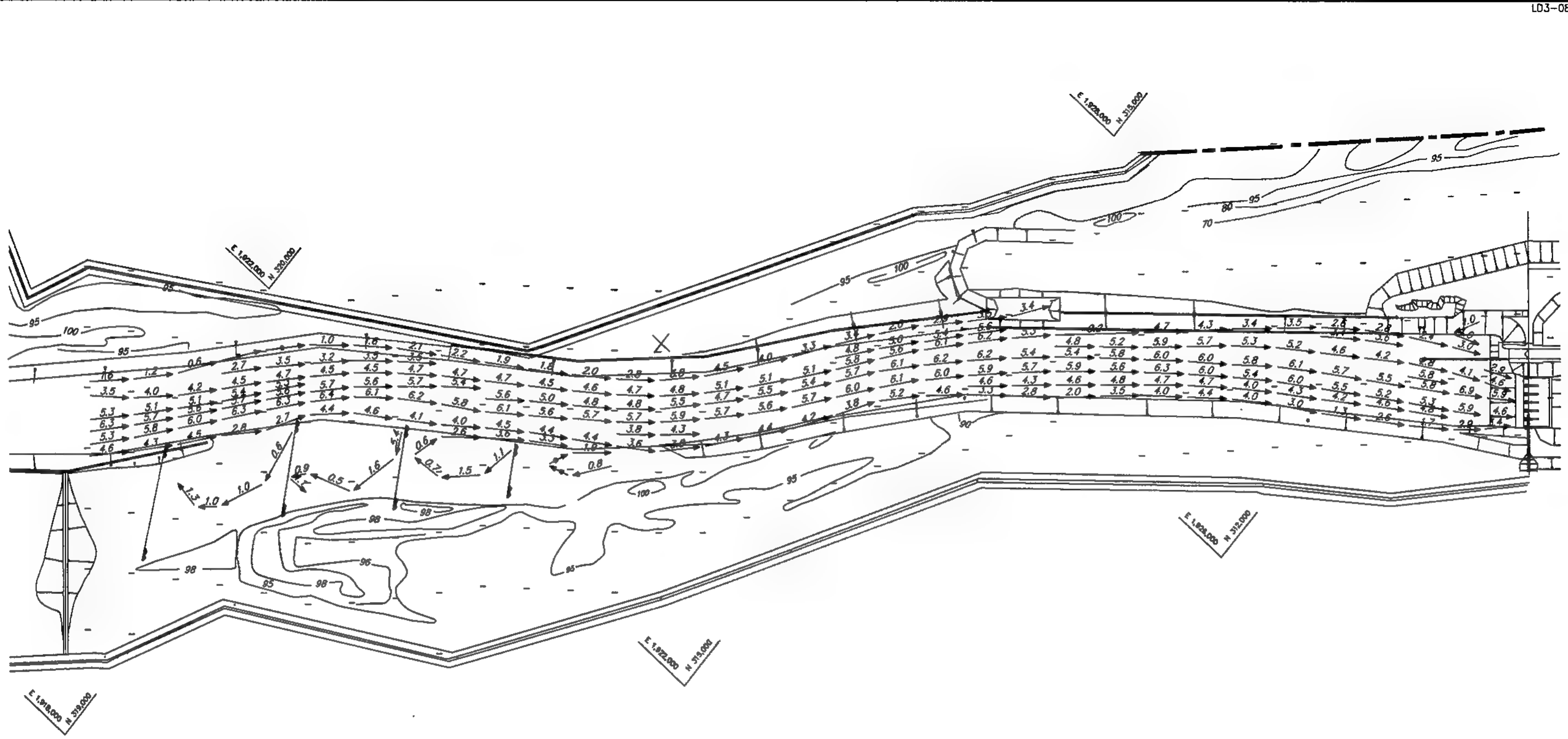
MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I-3

DISCHARGE: 60,000 CFS
UPPER POOL EL: 94.0 FT

LD3-085



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

●→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500 2000

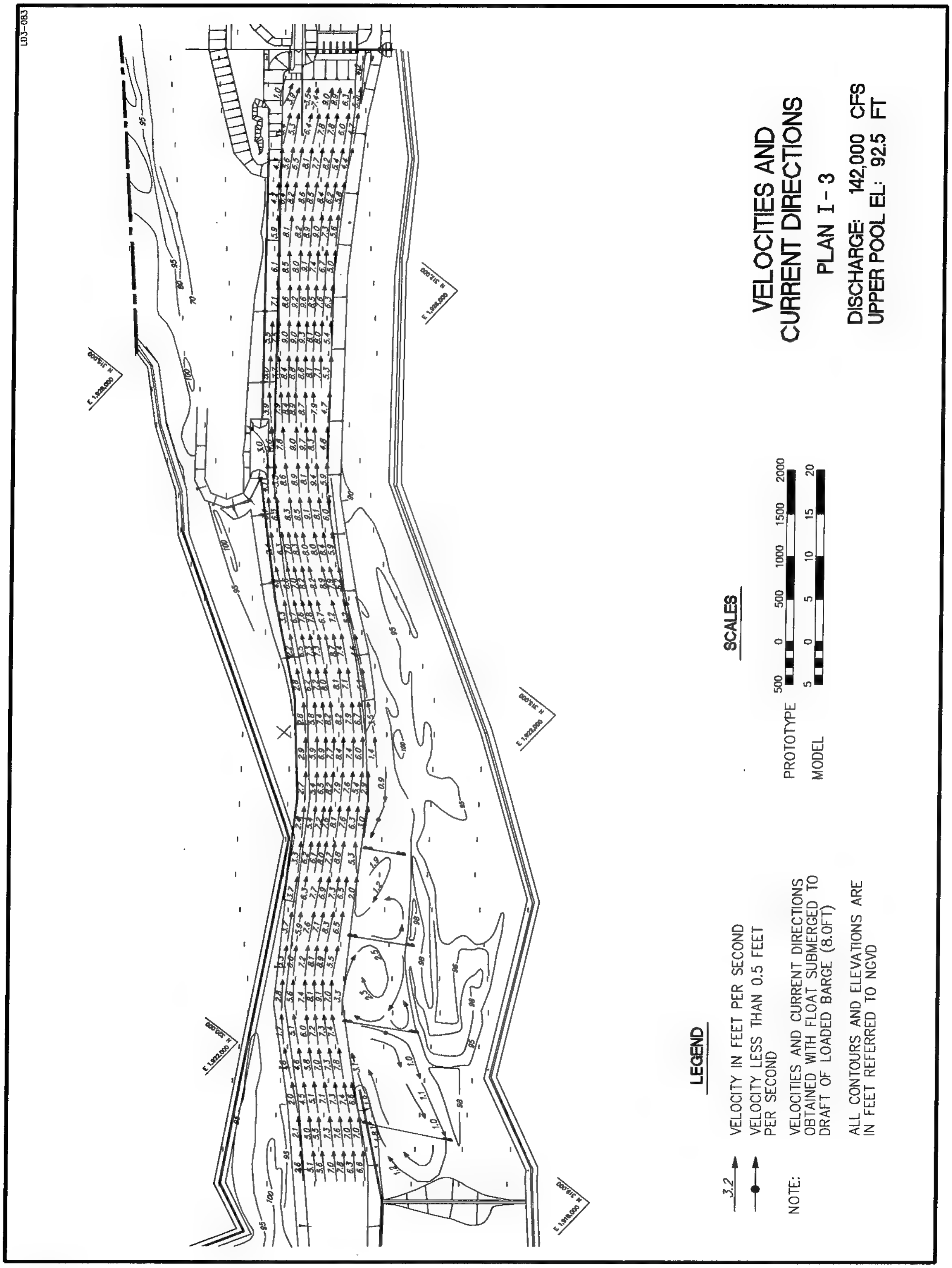
MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

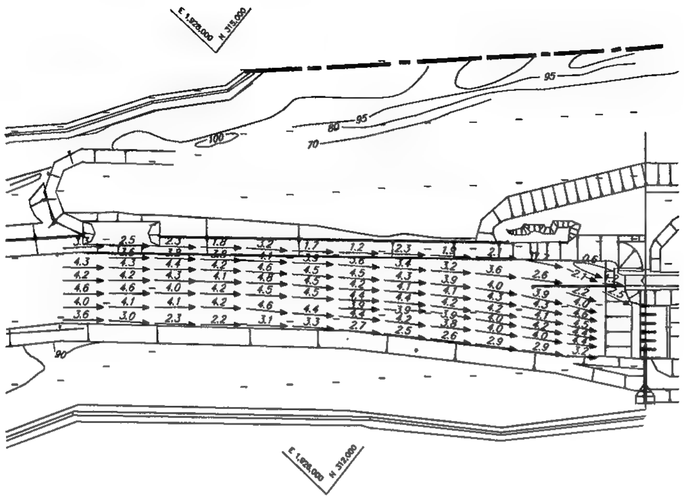
PLAN I-3

DISCHARGE: 80,000 CFS

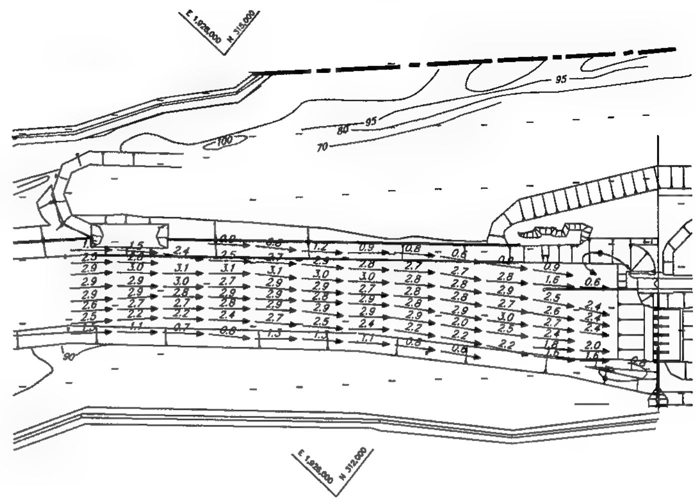
UPPER POOL EL: 88.0 FT


LD3-083
VELOCITIES AND
CURRENT DIRECTIONS
PLAN I - 3
DISCHARGE: 142,000 CFS
UPPER POOL EL: 92.5 FT
SCALES
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

LD3-100



DISCHARGE: 40,000 CFS
UPPER POOL EL: 85.5 FT



DISCHARGE: 40,000 CFS
UPPER POOL EL: 95.0 FT

LEGEND

3.2 → VELOCITY IN FEET PER SECOND

→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

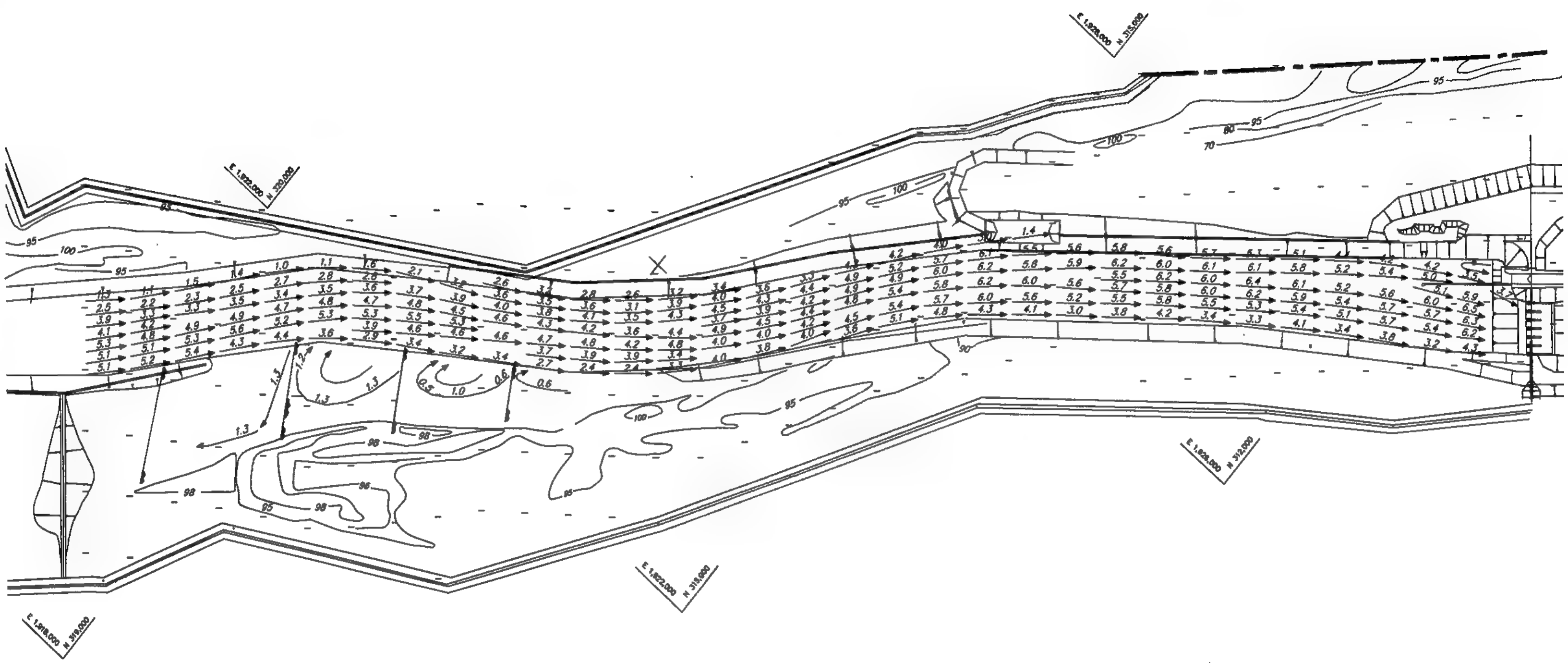
SCALES

PROTOTYPE 500 0 500 1000 1500 2000

MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I-1



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

●→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

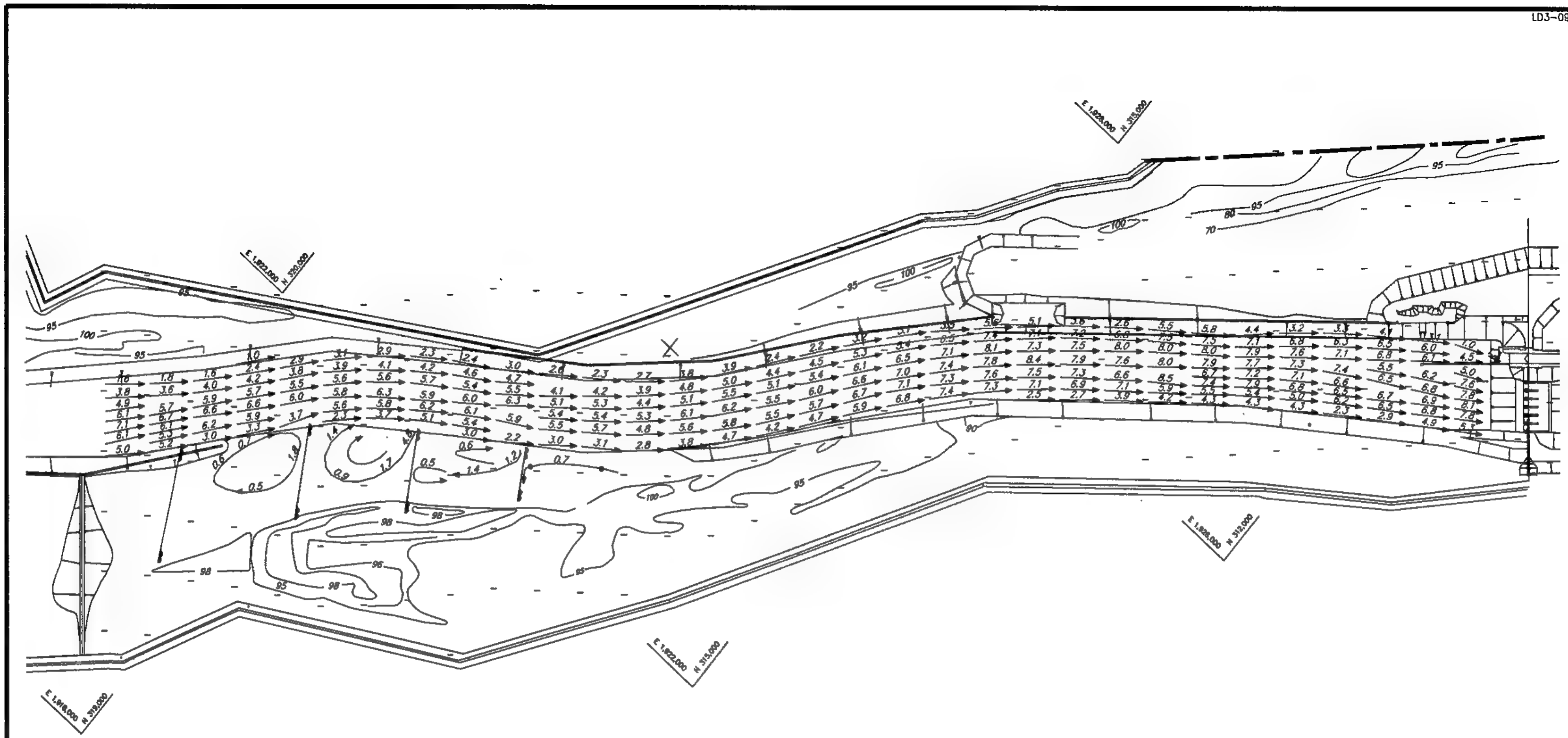
SCALES

PROTOTYPE	500	0	500	1000	1500	2000
MODEL	5	0	5	10	15	20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I-1

DISCHARGE: 60,000 CFS
UPPER POOL EL: 85.5 FT



LEGEND

3.2 →	VELOCITY IN FEET PER SECOND
—●→	VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500 2000

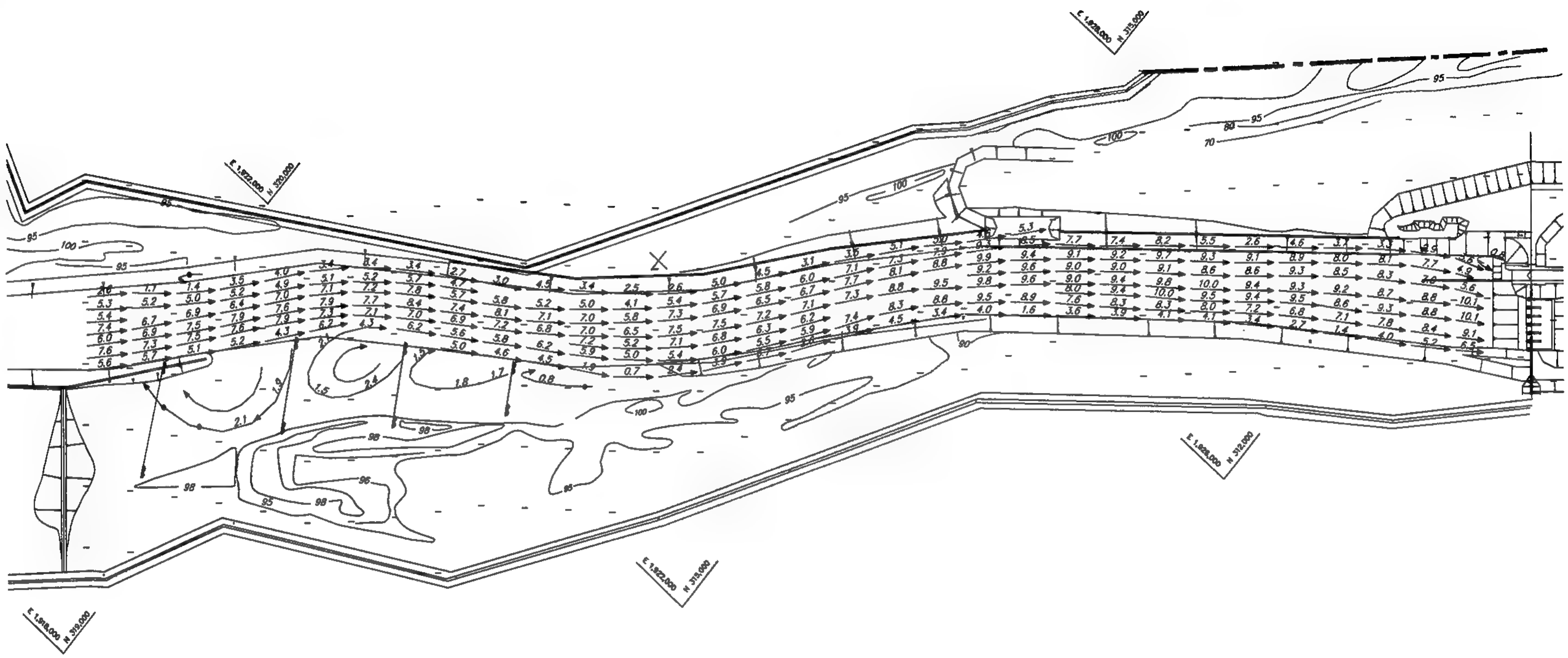
MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I-1

DISCHARGE: 80,000 CFS
UPPER POOL EL: 85.5 FT

LD3-095



LEGEND

3.2 → VELOCITY IN FEET PER SECOND

→•→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500 2000

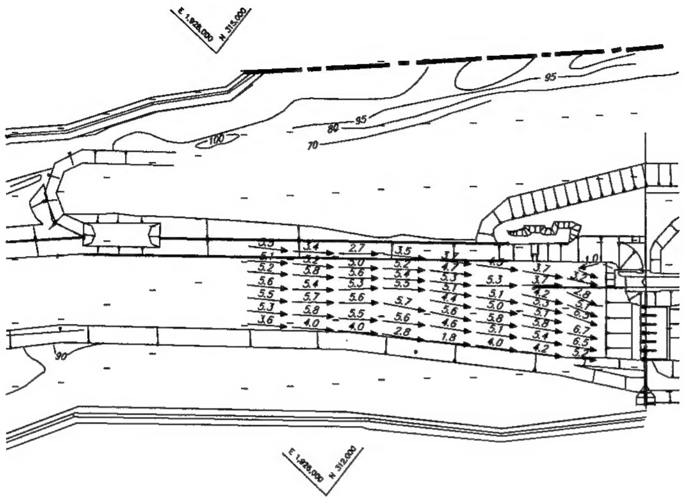
MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

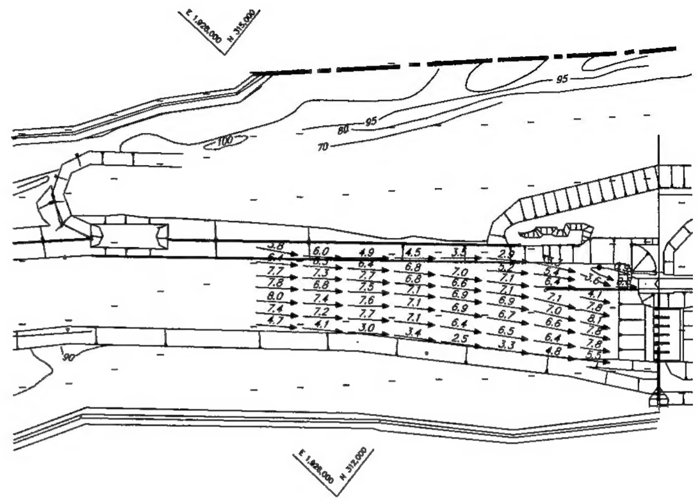
PLAN I -1

DISCHARGE: 100,000 CFS
UPPER POOL EL: 85.5 FT

LD3-099



DAM GATES 1,2 & 3 CLOSED
DISCHARGE: 60,000 CFS
UPPER POOL EL: 85.5 FT



DAM GATES 1 & 2 CLOSED
DISCHARGE: 80,000 CFS
UPPER POOL EL: 85.5 FT

LEGEND

3.2 → VELOCITY IN FEET PER SECOND

●→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 1500 2000

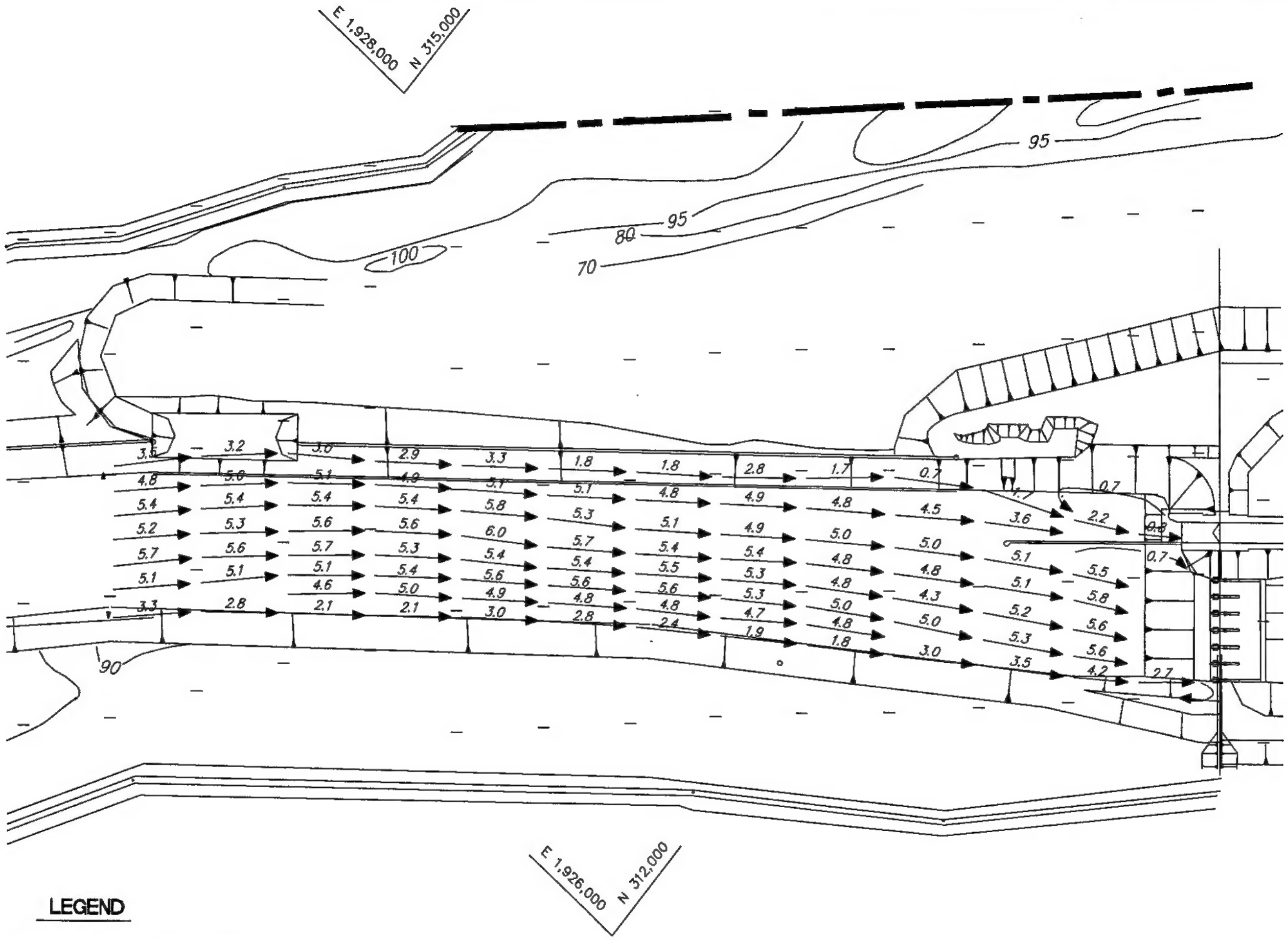
MODEL 5 0 5 10 15 20

VELOCITIES AND CURRENT DIRECTIONS

PLAN I-1

DAM GATE OPERATIONS

LD3-101



LEGEND

3.2 →	VELOCITY IN FEET PER SECOND
—●→	VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000

MODEL 5 0 5 10

VELOCITIES AND CURRENT DIRECTIONS

PLAN I-1

DISCHARGE: 60,000 CFS

UPPER POOL EL: 88.0 FT

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13.ABSTRACT ***(Maximum 200 words)***

Lock and Dam 3 is located on the Red River, in a cutoff channel between 1967 river miles 140 and 142, and about 53 channel miles above John H. Overton Lock and Dam. The lock and dam will be the third lock in a series of five locks and dams designed to furnish the required maximum lift of 141 ft to provide year-round navigation on the Old and Red River Waterway from the Mississippi River to Shreveport, LA, a distance of 236 miles. The principal structures are an 84-ft-wide by 685-ft-long lock, a spillway containing six 60-ft-wide by 42-ft-high tainter gates, and a 315-ft-long fixed-crest weir adjacent to the gated spillway. The dam provides a navigation pool that extends upstream to Lock and Dam 4. The dam is operated to maintain a navigation pool of el 95.0 at the dam (all elevations (el) cited herein are in feet referred to the National Geodetic Vertical Datum). A fixed-bed model reproduced about 3.5 miles of the Red River and adjacent overbank from about 13,500 ft upstream to about 4,800 ft downstream of the dam to an undistorted scale of 1:100.

Since Lock and Dam 3 was to be constructed in an excavated channel bypassing the natural river channel, it was important that the alignment of the channel and the arrangement of the lock and dam be satisfactory for navigation. The model investigation was concerned with evaluation of navigation conditions for proposed lock designs and development of modifications required to ensure satisfactory navigation conditions. The study identified any needed modifications to the

(Continued)

14.SUBJECT TERMS

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Hydraulic models	Navigation conditions
Lock and Dam 3	Red River

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13. (Concluded).

navigation channel alignment, guard wall lengths, or remedial structures. Results of the investigation revealed that a system of structures was required to eliminate adverse current patterns and establish satisfactory navigation conditions for tows entering and leaving the upper lock approach. A ported upper guard wall was required to reduce outdraft near the upstream end of the guard wall, and a system of closure blocks placed in the three ports closest to the lock reduced the forces acting on the tow in the upper lock approach. A 286-ft-wide navigation channel, aligned to eliminate any impact on the transmission tower along the right bank downstream of the dam, provided satisfactory navigation conditions for tows entering and leaving the lower lock approach.